

Human resilience to climate change and disasters: Response from University of Exeter

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1. What are the key components of human and social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

The key component of social resilience in the face of climate change risks is the ability to absorb and deal with climate changes and shocks and re-organise without undesirable or catastrophic changes to individuals or communities. Climate change will be experienced in the human time scale as a series of creeping processes, but more immediately as a series of discrete and extreme events. Hence social resilience is critical in the context of these perturbations and upheavals that will constitute climate change. The ability to absorb and deal with climate change is determined, and often measured *ex ante*, by focusing on assets and resources required for learning from the risks and reducing vulnerability into the future.

Social resilience, like other facets of human wellbeing, is comprised of objective and subjective elements. Objective elements relate to actual capacities and capabilities such as natural, human and financial capital. Subjective dimensions refer to how people perceive climate change risks and their own adaptive capacity. For individuals and communities, self-perceptions of resilience invoke issues of place and identity – such as the ability to keep on living in a locality and making a living there. Subjective dimensions of resilience are, therefore, difficult to substitute or replace and are built through social relations. But as many have argued, they are no less important or tangible for the fact they are not easily reduced to metrics (Adger et al., 2011a).

Social resilience to climate change is primarily concerned with individuals and communities and has important socio-demographic traits. Social resilience is also intricately linked to the resilience of the broader political and ecological systems in which populations, settlements and economies are embedded. There is significant documented evidence of potential trade-offs between social resilience (which by definition maintains well-being) and system resilience, where resilience of the ecological resource base, for example, may require human adaptations that reduce wellbeing (Coulthard, 2012). These trade-offs will play out at different spatial and temporal scales. For instance, a community's resilience to climate change and weather-related hazards may be enhanced by converting assets now which cannot be used in the future (e.g., depleting timber stocks for capital investment) or utilizing assets from other places (e.g., imported energy) with implications for the social resilience of people in the future and in other places. Trade-offs between individual and system resilience are not yet well understood.

There are two specific demographic dimensions to social resilience in the context of climate change and disasters. The first is that what resilience means for an individual will change over their lifecourse. In other words, resilience for younger people, elderly populations, and people in employment may be rather different. This is an emerging area of research: while there has always been recognition of the gender and age dimensions of climate change impacts through direct impacts on health (Denton, 2003; McMichael et al., 2006) there is growing recognition that specific cohorts construct their identity through occupation, through the ability to live independently and through their framing of one's life history. Place attachment and identity also change over an individual's lifecourse and these changes can affect adaptive capacity. For example research on resistance to migration and on occupational identity demonstrate the highly contextual and differentiated nature of social resilience to climate change and the impact these social processes have on adaptive capacity (Marshall et al., 2012).

The second demographic aspect of resilience is that of mobility. Discussions of climate

change in this area have frequently characterized movement of people and displacement as a failure of adaptation and focused on the loss of resilience (summarized in Adams and Adger, 2013). But in this area there is also emerging research concerning the role of mobility as adaptation options in the face of climate risks that promote or sustain resilience (Adger et al. 2002; Wrathall, 2012). New research shows that the effectiveness of migration as an adaptation strategy for individuals depends on capabilities, levels of assets and resilience prior to migration (Warner and Afifi, 2013).

But an important emerging finding suggests that mobility, resilience, and climate risks interact in both sending and receiving areas. In other words, growing cities, the destination of migrant populations, will be crucibles of risk for climate change impacts into the future (Foresight, 2011). Hence social resilience in the face of climate change is neither indicated by migration, nor solved by migration. Rather, mobility is a key element of resilience in the face of climate change that requires greater attention, not least because climate change impacts will significantly alter the economic terrain and attractiveness of areas with both growing and declining populations and economic opportunities.

2. What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

Adaptation is about deliberate action to adjust to risk, and involves decisions. Hence much normative assessment of adaptation draws on standard decision analysis and public policy tools to analyse both public and private decisions (see Patt, 2013 for example). These include multi-criteria assessment, formal risk assessment, cost-benefit analyses and others. A summary of how these are relevant to adaptation decision-making was outlined in Adger et al. (2005) that examined what constitutes successful adaptation. Here the principal criteria to judge success are those of efficiency, effectiveness, equity and legitimacy. These criteria are essential for both the practical implementation of adaptation options. But they are also critical, we argue, to ensure that adaptation is harmonious with culturally specific and wider held values in society and for building trust in the institutions of governance. Emerging issues on the appraisal of adaptation include:

- The relative role of public and private action (as analysed through social contracts), and the role of regulation versus markets for implementation. The shifting remit of responsibility between state and citizens for adaptation to environmental risk may potentially create vulnerabilities and there is renewed interest in the role that the insurance industry may play as responsibility around risk management changes (Adger et al., 2013).
- Risk-based appraisal methods and perspectives Dow et al. (2013) use a risk framework to understand an actor's capacity to secure a particular valued objective through adaptive effort, using the concepts of acceptable, tolerable and intolerable risks. They note that both the valued objective and the point at which the objective is deemed exposed to intolerable risk is shaped by institutional and social values and is thus highly contested.
- The incorporation of probabilistic scenario information into risk averse planning. Scenarios do not predict the future but build pictures of what might happen under different configurations of uncertainty (e.g., uncertainty in emission, climate impacts or governance). Probabilistic scenarios attempt to qualify or quantify uncertainties more precisely than simply outlining a best-case and worst-case scenario. They do so using probability distributions; weighting the likelihood of risk. So, a range of futures can be explored, of varying likelihood, and from these the statistical distribution of potential impacts to social resilience can be estimated.
- Consideration of the potential for maladaptation, identified as actions taken ostensibly to avoid or reduce vulnerability to climate change that impact adversely on, or increases the vulnerability of, other systems, sectors or social groups (Barnett and O'Neill 2010)

Marshall et al. (2010) provide a practical manual for assessing climate related vulnerability in coastal communities that can be then used to inform decisions about coastal management

with the aim of building resilience. Moser and Ekstrom (2010) put forward a framework to help identify barriers to climate change adaptation. Identifying the role of actor's, context and the system of interest are key in fully understanding the construction of barriers and how they may be addressed. They emphasize the highly contextual nature of adaptation and suggest that prescriptive lists or indicators are inappropriate in providing methods to overcoming barriers and that diagnostic frameworks offer the flexibility needed for the task.

4. Are there studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?

Adger et al. (2011b) compare the impacts of response strategies of climate change on wider social and system resilience of related social-ecological systems. The study uses common resilience criteria and expert judgment by a group of resilience scientists to identify how adaptation strategies can inadvertently enhance or reduce the resilience of a system. For example, biofuel expansion in the US as a climate policy response has led to a reduction in soil conservation technologies, in other examples adaptation is leading to a reduction in ecologically sound practices and irreversible change to ecosystems. The authors find overall that policies that may be judged a success through an adaptation lens may be judged a failure using a wider resilience framing where system resilience is being undermined. This study highlights the challenges faced by decision makers and the trade-offs that will emerge between policy objectives focused on adaptation metrics, and strategies that aim to retain and increase system resilience.

Many studies in this area reflect a wider concern that climate change responses may have inadvertent or systematic negative impacts on underlying system resilience. Part of this concern is reflected in analyses of so-called maladaptation (Barnett and O'Neill, 2010), but also in the impacts of large-scale land-related fossil-fuel substitution technologies such as hydro-electricity or REDD-type measures. Their potential for population displacement and resettlement, for example, has become an issue of concern (de Sherbinin et al., 2011).

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Questions

How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?

- Frequency and intensity of extreme weather events (droughts, floods, heat stress, and storms) will increase in South Asia (IPCC 2007)
- Sea level will rise due to high temperatures and accelerated glaciers melt

Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

Not well quantified as such but expected changes in rainfall intensity and frequency would cause more losses than other risk factors.

The exposure and vulnerability to such events is projected to further increase.

What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

Key components of resilience:

- Increased investment in agriculture to bridge current yield gaps
- Application of a portfolio of risk management approaches including diversification, NRM management, climatic services, and market linkages
- Sustainable and equitable use of natural capital (e.g. land, water, forest, and ecosystem products/services)
- Early preparedness to avoid extreme climate events (e.g. floods, storms, long drought)

Indicators for evaluation:

- Investment in agriculture especially in developing strong early warning system and alternative plans to avoid extreme climate events
- Access to and use of natural capitals by vulnerable communities
- Policies and plans for short and long-term climate risk adaptation and mitigation
- Growth of non-natural resource based sectors (industry and service sectors)

Who are the real adaptation decision-makers / where are adaptation decisions really made?

Real adaptation decision-makers:

- Farmers (in agriculture), businessmen (in industry) and local natural resource users (land, water, and forest)
- Policy makers and implementers at various level (national, sub-national and local levels)

Adaptation decisions:

- Implementation of climate smart practices (in agriculture and non-agricultural sectors)

- Policy reforms and develop new policies by policy makers
- Investment decision made by national, sub-national and local governments to promote climate smart practices

What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

CCAFS is working on agriculture sectors. Thus, assessment tools and decision-making framework developed/assessed by CCAFS are more confined to this sector.

- Tools for crop yield forecasting
- Tools to inform decision making on investment in climate smart agriculture technologies and practices
- Case studies and demonstrations for scaling out climate smart agriculture via change in policies and institutions
- Regional databases for enhanced climate change impact assessments and prioritization

What are the most commonly discussed and implemented adaptation approaches for protecting against, reducing sensitivity to, and allowing recovery following, weather-related hazards?

- Water management at different scales
- Climate-smart- village (implementation of climate-smart agricultural practices)
- Climate index based insurance for farmers

Are there any studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?

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Success was measured based on frequency of climate smart agriculture adaptation and changes in policies.

To what extent, and under which circumstances, can ecosystem-based approaches be integrated with other adaptation approaches (eg. those that involve hard infrastructure, technology and social interventions)?

Table 1: Application of ecosystem-based approaches integrating with other adaptation approaches (conventional approaches)

| Potential climate change impact | Conventional solution | EbA solution |
|---------------------------------|-----------------------|--------------|
| | | |

| | | |
|-------------------|---|---|
| Drought | Irrigation infrastructures, rainwater harvesting, drought resistant varieties | Cover and green manure crops, conservation tillage, agro-forestry, forest conservation, establishment of protected areas, wetland restoration, soil moisture management, grassland management, crop diversification |
| Heat stress | Heat resistant varieties, adjustment of planting and harvesting times | Shade trees, intercropping, crop diversification |
| Flood | Dams, streambank, diversions, terracing | Riparian Buffer, contour farming, filter strips, vegetative buffer |
| Pest and diseases | Pesticides | Ecological Pest Management (EPM), crop diversification |

In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?

- Co-benefits, costs of implementation and benefits, priority of stakeholders, easiness for implementation, potential of greenhouse gases mitigation, sustainable use of natural capitals, reduce inequality and poverty, improved governance etc.

To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?

- The aim of EbA should be to enhance ecological services that are essential for resilience to the pressure of climate change in medium and longer term. Therefore, the EbA approach should include long-term strategies such as conserving watersheds, developing agro-forestry, forests restoration, preserving wetlands etc. which can support sustainable supply of ecosystem services.
- Some of the key services that a healthy ecosystem can provide to support adaptation to climate change are freshwater provisioning (irrigation during drought), crop pollination, biodiversity (develop heat and pest/diseases resistant varieties), and pests and diseases regulation.

What are the appropriate scales for, constraints, distributional consequences and trade-offs of ecosystem-based approaches?

Appropriate scales

- multi-levels (local-sub-national-national-regional-global)

Constraints

- Investment on ecosystem-based approaches of climate change adaptation
- Difficult to quantify the benefits of EbAs

Distributional consequences

- Inequitable distribution of benefits (for instance: people in the downstream get most of the benefits from the forest conservation and freshwater provision from the investment in the upstream)

Trade-offs of ecosystem-based approaches

- Most of the EbAs are complementary to each other and with hard infrastructures and technologies of climate change adaptation.

**To the
Royal Society
“Human resilience to climate change and
disasters project”**

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Submission of evidence “Human resilience to climate change and disasters project”

Understanding spatial-temporal patterns and scales of variability is key to the problem of human resilience to climate change. This is because the *variability* of temperature and rainfall over space and time determines extreme events like flooding, drought and heatwaves, and not the annual average values. Ecological processes that are driven by changes in the scaling behaviour of temperature and rainfall can interact with weather and climate at many different spatial and temporal scales, leading to highly complex and apparently random behaviour in resulting parameter measurements (Callaghan et al., 2013). As a general rule, simpler ecosystems behave in a more systematic and more predictable way (Pimm, 1984), making it easier for humans to build resilience against extreme events in such systems. Ecologists have to be mindful to quantify how spatial heterogeneity of landscapes affects species distributions (Fortin et al., 2012), for example. The progress made in remote sensing and Geographical Information Systems (GIS) allows analyses at multiple spatial and temporal scales (limited by the repeat frequency and spatial resolution of these observing systems and other limiting factors). For the analysis of temporal scales of variability in ecological data, statistical methods have been developed, including wavelets, variogram analysis, fractal analysis, spectral transform analysis and others. The principles of wavelet analysis of ecological time series are described by Cazelles et al. (2008). This method allows for non-stationarity in time-series data (Rouyer et al., 2008). Wavelet analysis has commonly been used to analyse scales of variability in ecological studies, for example to investigate the cyclicity of gypsy moth (*Lymantria dispar*) outbreaks in the United States (Allstadt et al., 2013), to analyse spruce budworm (*Choristoneura fumiferana*) outbreaks and the influence of landscape-scale forest management in Minnesota and Ontario (James et al., 2010, 2011); to understand the role of environmental factors in the dynamic forcing of oviposition of the southern house mosquito (*Culex quinquefasciatus*) (Chaves and Kitron, 2011); to develop a multi-scale inversion method to interpolate spatiotemporal ecological variation from sparse field observations (Chiao et al., 2012); and for examining the spatial variation of soil properties (Biswas and Si, 2011). Wieland et al. (2011) describe Multi-Scale Landscape Analysis (MSLA) as a method to identify correlation of relief with ecological point data. Such scale analysis methods need to be applied to further our understanding of extreme weather events and unusual climate patterns. By understanding the scaling properties of meteorological observations from weather stations and satellite data records, we can improve the representations of climate processes in global climate models and assess whether the simulations match the observed scaling behaviours. This is critical to ensure that future predictions give credible scenarios for climate adaptation. Building human resilience relies on an understanding how changing scales of variability affect everyday living conditions and the risk of natural disasters. This poses challenges as to how this quite complex issue can be communicated to the public and the media.

As a general ground rule, I personally would recommend that human resilience has to *anticipate the unlikely*. If unexpected events with a very low likelihood of ever occurring can be anticipated, then human infrastructure of the future will be able to cope with a range of – sometimes unexpected – climate impacts and natural disasters.

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I hope you find this submission useful food for thought and it helps your consultation.

Best regards,



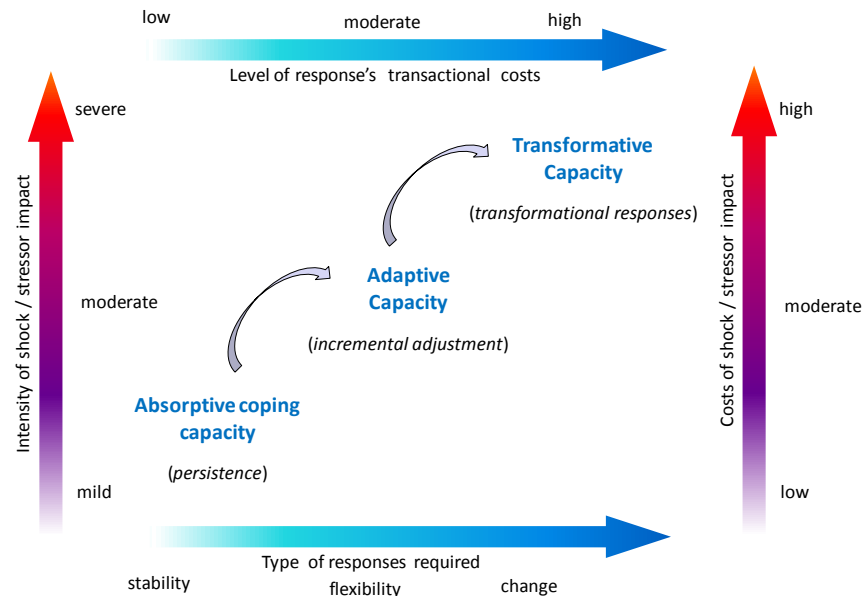
What are the key components of human / social resilience to climate change, and how can they be evaluated (e.g. measured or ranked)?

Chris Béné, IDS
Nov. 2013

Definitions

Human / social resilience refers to the (i) absorptive, (ii) adaptive, and (iii) transformative capacities that individuals, households, groups, communities and societies develop to reduce the risk of long-term detrimental impacts induced by specific adverse events (shock/stress) (Béné et al. 2012). In essence this conceptualization of resilience¹ means that building resilience requires interventions that strengthen the three components (absorptive, adaptive, and transformative resilience) together. It also means that in their response to adverse events, people don't simply try to reduce the detrimental impact of these shocks; they also try to (a) minimize the costs it takes to respond and (b) to recover from these events. Resilience outcomes therefore result from trade-offs and combinations between three different dynamics: (i) intensity of shock, (ii) costs of impact, and (iii) costs of response –see Fig.1 below.

Figure 1. Conceptualisation of resilience in relation to its constitutive elements (Source: derived from Béné et al. 2012 and von Grebmer 2013).



Resilience components

By “key components of human / social resilience to climate change”, I am assuming the Working Group means the different objective and subjective elements that facilitate –or hamper– individual, group or societies to engage/invest in one -or a combination of two or the three-

¹ This conceptualization of resilience is human-centred but can in theory also be applied to ecological resilience: we would for instance talk about the (lack of) absorptive capacity of a lake in relation to eutrophication or the poor (or good) adaptive capacity of an ecological community to sustain anthropologic pressure.

components of resilience described above. In that case, the main social factors that affect social/human resilience are:

- perceptions of risks and changes,
- (access to) knowledge and information,
- beliefs, culture,
- social rules and norms,
- collective actions – coordination, social cohesion
- power relation, and
- governance

Note that I don't call these: "components" of human resilience, but "determining factors", in the sense that these do not constitute parts of social/human resilience *per se* but are factors that can either help or debilitate people and societies' resilience. Pelling and Manuel-Navarrete (2011), for instance, demonstrate how power and existing institutional structures undermined the transformative capacities of urban communities in Mexico: "By closing down imagination, discussion of alternative values, and organization, dominant structures, and social agency simultaneously support and undermine resilience" (Pelling and Manuel-Navarrete 2011, p.19).

Other empirical analyses also suggest that social capital can in some cases be detrimental to community resilience. Coulthard (2011) for instance shows how fishing communities in India characterized by a very strong social identity built around their traditional customary management system eventually turned out to be less resilient than other groups that show lower level of loyalty to these customary systems: "the high social values attributed to the Padu system, alongside complex power structures, [had] hinder[ed] institutional adaptation" (Coulthard 2011, p. 405).

Yet in other circumstances, analysis of subjective level of resilience show how leadership and 'good' governance has been critical in unlocking the capacities of Pacific islands' communities to adapt to change (Schwarz et al. 2011).

These few empirical studies are path-breaking because they provide a counter-narrative (or at least a nuanced alternative) to the widely spread view that 'social capital' or the likes (collective action, social fabric, etc.) are (positive) components of social/human resilience.

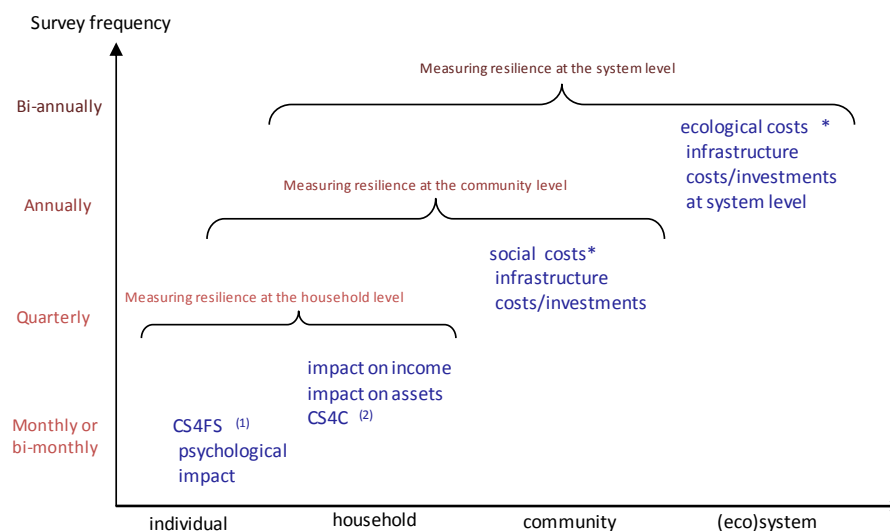
How to measure (social) Resilience?

As the discussion above should have made clear, using the level of social capital to measure or assess resilience would be misleading as there is no direct and linear relation between them. Yet a lot of NGOs and academics still insist in trying to equate resilience with community or even household characteristics such as social cohesion, or good governance. While it is natural to expect that communities characterized by strong social bounds and/or good accountability mechanisms will be more 'effective' at responding to their members' needs, and as such are in theory in a better position to address local population's exposure to risks and needs for adaptation (Adger 2003, Tanner et al. 2009), the empirical studies quoted above demonstrate this is not always the case. Social resilience cannot therefore simply be measured by the level of social cohesion (or even the access to information, or the 'quality' of the local governance).

In one of the very few studies with some form of quantitative measure of households' resilience, Carter and his colleagues (2007) found that in communities affected by climate-related shocks, the poorest are (a) often hit proportionally harder than the better-off (i.e. they lose proportionally a larger share of their assets), and (b) they also seem to be slower at recovering. From these results, many would conclude that resilience is strongly determined by households' assets -and consequently that assets (or capitals) could be used as a good proxy for measuring resilience. There is however a real danger to adopt such an approach. While useful in helping us understand what type of resources/assets people need to 'bounce back' or to adapt / transform, using asset as a proxy for resilience would tend to mask the role of less tangible but possibly far more important factors such as, e.g., perception, the fostering of innovation and experimentation, the exploitation of new opportunities or the structure of institutions and entitlements.

In sum, as discussed somewhere else resilience is notoriously difficult to measure (Béné 2013). In that same paper I argue however that while there is currently no robust method to measure resilience, one potential avenue is the recognition that resilience can be monitored/estimated by its "costs". By "resilience costs" I mean the various ex-ante and ex-post investments, losses, sacrifices, and costs² that people have to undertake at individual and collective levels to 'go through' a shock or an adverse event. The underlying principle of this approach is that the more resilient a system (or a component of this system) is, the lower the resilience costs that this system (or the component of this system) will experience to pass through a shock or a tough period. Based on this principle, resilience can be measured and monitored simultaneously at different levels, for different components of a system, and include both objective and subjective "costs" (see Fig.2).

Figure 2. The multi-scale nature of the resilience measurement framework and the associated sampling frequencies. Notes: ⁽¹⁾ CS4FS: coping strategies for food security; ⁽²⁾ CS4C: coping strategies for cash. Source Béné (2013).



² The use of the term 'costs' is hugely problematic here, given its close association in the literature with economic/financial (cost-benefit) analyses. We use it therefore in default of a better term, but resilience is not simply about economics or financial costs, it is also about social, psychological, or ecological 'costs'.

In that paper I also argue that a series of key-principles are critical to build an appropriate measure of resilience (Béné 2013). These key-principles are:

- **Multi-scale:** Resilience indicators should be able to capture change in resilience at different scales: individuals, household, community, (eco)system, national levels;
- **Multi-dimension:** resilience is not simply about coping strategies that help households to 'survive' a shock; resilience is also about adaptive strategies or even transformative strategies. It is about ex-post but also ex-ante (anticipation) strategies. An appropriate resilience indicator would be one that captures all these different dimensions.
- **Objective and subjective:** resilience is as much about what people do to go through a harsh period, than about how they feel about it. Resilience indicators should therefore aim at monitoring both objective changes and subjective perceptions – including stress.
- **Generic:** Although we recognise that indicators are relevant only if they can capture and reflect the specificity of the situation they are applied to, too many indicators are currently built on specific circumstances or specific agenda. An appropriate resilience indicator is one that can be scaled out and replicated.
- **Independently built:** to be analytically useful, a resilience indicator needs to be defined and measured independently from the factors and processes that are (presumably) affecting its level, such as income, assets, level of participation or social coherency. Only when these factors are not incorporated in the resilience index can we explore and test rigorously the actual effect of these characteristics on resilience.

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How will weather-related hazards change in their frequency, intensity and location by a) 2030 and b) 2100?

Variability and change in the climate system

The Earth's climate system exhibits natural variability on all time scales. Climate change caused by greenhouse gases emitted due to economic activity will be an increasingly important factor during the rest of the century. The impacts of this climate change will manifest in parallel with existing natural variability on decadal and inter-decadal timescales.

Weather-related events already impose significant costs on society, despite a high degree of adaptation to the current climate. For example, the recent superstorm Sandy is estimated to have caused some US\$65 billion of damage in the US, while a severe tropical cyclone over southern Myanmar in 2008 created a devastating storm surge that resulted in more than 100,000 deaths. Particular modes of climate variability, such as the El Niño Southern Oscillation (ENSO), may be associated with distinct and sometimes damaging patterns of weather over a number of regions. The seasonal monsoons on which many people depend for their livelihoods can also cause significant damage and loss of life.

The impact of a specific weather event depends on its nature and intensity, the level of exposure of society or natural ecosystems to that event and their level of vulnerability to the hazard. Over time, recurrent hazardous events can reduce economic growth through their effects on human and physical capital and productivity. The probability of occurrence of at least some weather related hazards is likely to change significantly over the timeframe in question as the effects of climate change become more apparent.

Projecting future climatic conditions

Climate models provide information about the expected climatic conditions and potentially allow societies to plan for future changes. Models vary in their degree of complexity and resolution and the extent to which they include key earth system processes. The majority of the models used in the IPCC Fifth Assessment Report (AR5) are coupled atmosphere-ocean general circulation models (GCMs). These highly complex and computationally intensive models are based on our best physical understanding of the processes that drive the climate, including both the well-established equations governing the behaviour of the atmosphere and ocean as well as a parameterised representation of important processes that occur on a smaller scale than the models can resolve, such as cloud formation and precipitation. There are now even more complex Earth System Models (ESMs) that incorporate additional features of the climate system such as the carbon cycle.

Since we cannot perform scientific experiments with the entire climate system, models are a key tool for exploring our understanding of the system and for making projections of future climate based on our current understanding. However, no model can be a perfect representation of the actual system. In particular, the IPCC AR5 Working Group 1 report suggests that some models may be too responsive to the effects of greenhouse gases. Nor do we yet fully and quantitatively

understand the mechanisms responsible for the recent slowdown in surface warming. All model projections should be assessed on the basis of a sound physical understanding of the processes at work; less complex models can help illuminate the results of the GCMs and ESMs.

There is a cascade of confidence in projections of the GCMs. There is very high confidence in the occurrence of global warming due to human emissions of greenhouse gases. There is moderate confidence in aspects of continental scale climate change projections. There is some confidence in trends for precipitation on the same scale. The results of global climate models are often at too low a resolution to inform regional or local responses to climate changes, though there are impressive efforts to increase the resolution by a number of modelling groups. The models used by the IPCC in AR5 have a typical resolution of roughly 2 degrees latitude/longitude, but this varies fairly significantly between models (see Table 9.A.1, Chapter 9, AR5 for more details).

To overcome this limitation, significant effort has been devoted to downscaling GCM projections or to embedding a regional model within the boundary constraints provided by a GCM. There is a dangerous perception in the impacts and policy communities that the climate projection problem is essentially solved and that downscaling from current global climate models provides a firm basis for determining impacts and the requirements for adaptation at a regional level. However, 25km scale climate change information is indicative to the extent that it reflects the large-scale changes modified by local conditions. There is no climate change information in the 5km data beyond that at 25km. All that can be produced is a range of examples of local climates consistent with current larger-scale model projections. The confidence in the climate change information also depends strongly on the variable under discussion.

Projections to 2030

i. Caveats

Projections of near-term climate change suggest only small sensitivity to the actual emissions pathway until after 2030. However, there is greater sensitivity to uncertainties in aerosol emissions, particularly on regional scales and for features related to the water cycle.

There is limited ability in the GCMs at present to represent well the statistics of the weather regimes that affect particular regions, including for example the UK. There can therefore as yet be little confidence in climate projections on decadal time-scales. For example, for the UK there is currently little confidence in whether the frequency of storms will increase or decrease. Downscaling cannot solve this problem.

There is much research into the understanding, techniques and measurements that will enable climate models to forecast the behaviour of slow, decadal time-scale modes of variability in the climate system, for example the Atlantic Multi-decadal Oscillation. However the climate model projections which provide the current basis for the determination of impacts and the requirements for adaptation for the next few decades do not contain good simulations of the variability on those time-scales.

The big challenge for climate science in the next decade is therefore to provide useful predictions of regional climate change statistics for the next few decades so as to provide a basis for more advanced adaptation strategies.

ii. Projected near-term changes in temperature and precipitation

Near-term warming from past emissions is unavoidable due to the thermal inertia of the ocean. This will be increased by future emissions, but also strongly influenced by the internal variability of the climate system and changes in external forcing due for example to large volcanic eruptions or significant changes in solar forcing. Local and regional responses in precipitation and in mean and extreme temperature to land use change will be larger in some regions than those due to greenhouse gases and aerosols.

IPCC AR5 assesses that it is likely that the global mean surface temperature anomaly over the period 2016-2035 relative to the period 1986-2005 will be in the range 0.3°C to 0.7°C. AR5 also says that it is very likely that surface warming will be more rapid over land areas than over oceans and that warming over the Arctic in winter will be greater than the global mean warming. These changes to planetary temperature gradients will drive responses in the weather systems.

AR5 expects increases in the frequency of warm days and warm nights in more regions with a reduction in the frequency of cold days and cold nights. Models project increases in the duration, intensity and spatial extent of heat waves and warm spells in the near-term. Changes to the current distribution of temperatures may be complex, with the mean temperature warming at a different rate to those associated with the higher-end of the distribution. In the near-term, AR5 judges that it is very likely that the frequency and intensity of heavy precipitation events will increase over land, in agreement with ideas based on basic atmospheric physics.

iii. Changes in the atmospheric circulation and natural variability

In the early 21st century, AR5 thinks that it is likely that the annual-mean Hadley Circulation will extend and the Southern Hemisphere mid-latitude westerlies will shift poleward, but not as rapidly as in recent decades (AR5). There is however low confidence in the near-term projections of the position and strength of Northern Hemisphere storm tracks. Equally, there is low confidence in basin-scale projections of changes in intensity and frequency of tropical cyclones in all ocean basins. There is low confidence in projection of increased tropical cyclone intensity in the Atlantic, which is in part due to projected reductions in aerosols.

iv. Changing hazards under climate change

Change in the risk of flooding by 2030

The main types of flooding are: coastal, fluvial (river) and pluvial (ground water through intense rainfall). Climate change could potentially affect the risk of all of these. Coastal flooding could become more common due to rises in sea level. Under climate change, rain is expected to fall in shorter, heavier bursts which could potentially increase the risks of fluvial and pluvial flooding.

IPCC projections suggest that global mean sea level is likely to rise by roughly 0.1 metres by 2030 relative to the period 1986-2005. These increases in sea level can be expected to be accompanied by increases in extreme high sea level, meaning that damaging storm surges are likely to become more frequent. It is thought that humans have already contributed to an increase in incidence or magnitude of extreme high sea level events, and a particular event like Sandy has a larger impact because of this.

There is likely to be an increase in the frequency and intensity of heavy precipitation events over land (AR4, SREX, AR5) and an enhanced risk of fluvial or pluvial flooding.

Changes in drought risk by 2030

As explained above, climate change is projected to change rainfall patterns significantly. According to the IPCC, there is low confidence in whether there will be an increase in the duration or intensity of drought by the 2030s. This assessment combines AR4, AR5 and SREX.

Changes to the risk of heat waves by 2030

AR5 suggests a likely increase in temperature extremes, but with little distinguishable separation between emissions scenarios. Changes in extremes may take place at a different rate to mean surface temperature increases.

Projections to the end of the century

i. Caveats

Assessing changes in circulation and in climate extremes near a century hence is highly challenging. Often several different processes – dynamic and thermodynamic - operating in combination at different scales are required to produce a hazardous or extreme event, such as a heat wave, a flood or a drought.

ii. Climate change scenarios

Long-term projections are based on particular emissions scenarios. The scenarios used in the IPCC Fifth Assessment Report are known as “representative concentrations pathways” (RCPs). They are characterised by the amount of additional radiative forcing by 2100: the radiative forcing is a measure of the net additional energy in the climate system due to the emission of greenhouse gases and aerosols under each scenario. A larger number attached to the scenario therefore corresponds to higher greenhouse gas emissions and consequently more climate change. RCP8.5 is the most emissions-intensive scenario modelled in AR5, with the rate of carbon dioxide emissions slow after 2060 but continuing to grow in absolute terms to the end of the century. RCP2.6 is a scenario with very significant emissions reductions and some removal of carbon dioxide from the atmosphere in the latter part of the century. In the text below, when the terms “limited mitigation scenario” and “strong emissions reduction” are used they refer to RCP8.5 and RCP2.6 unless otherwise stated.

iii. Projected long-term changes in temperature and precipitation

We have a lot of confidence that global mean surface temperature will continue to increase, with warming in almost all regions and with larger warming over land than over the oceans. The magnitude of the increase is dependent on emissions (see Table 1 reporting IPCC AR5 projections) and varies between regions. In the absence of a strong reduction in the Meridional Overturning Circulation in the Atlantic, AR5 says the Arctic is projected to warm the most. Again, regional temperature differentials will influence weather patterns. There are virtually certain to be increases in hot weather extremes and decreases in cool weather extremes as global mean surface temperature increases.

Table 1: Projected long-term changes in global mean surface temperature for 2081-2100.

| Scenario | Mean | Change relative to 1986-2005 | Change relative to average for 1850 - 1900 |
|----------|------|---|--|
| | | Likely range (5-95% of model ranges) | |
| RCP2.6 | 1.0 | 0.3 - 1.7°C | Unlikely to exceed 2.0°C |
| RCP4.5 | 1.8 | 1.1 - 2.6°C | Likely to exceed 1.5°C |
| RCP6.0 | 2.2 | 1.4 - 3.1°C | Likely to exceed 2.0°C |
| RCP8.5 | 3.7 | 2.6 - 4.8°C | As likely as not to exceed 4°C |

With climate change, warming of the lowest part of the atmosphere allows the maximum level of water vapour there to increase. The maximum amount (technically the saturated partial pressure) of water vapour in the atmosphere also increases by about 7 per cent more for every degree of warming in typical atmospheric conditions. This means a 50 per cent increase in water vapour for a 6°C rise in temperature.

Global precipitation is expected to increase but by a smaller amount than water vapour in the atmosphere as the climate warms, perhaps by about 2 per cent per degree Celsius. When it rains, the episodes are expected to be more intense with an increased risk of floods. There is generally more uncertainty over future rainfall patterns than temperature changes but confidence is higher in some places than others. The sub-tropics are expected to dry while the tropics are expected to become wetter in a warmer climate due to changes in tropical circulation. Higher latitudes are also expected to get wetter.

iv. Changes in the atmospheric circulation and natural variability

The weather we experience could potentially be impacted by changes to the atmospheric circulation or by changes to the natural variability of the climate. There are various climatic phenomena which vary naturally, with far reaching impacts on the weather. Because of their complexity, changes in these phenomena are difficult to predict.

By 2100, the IPCC projects the following changes:

- In the tropics, the Hadley and Walker circulations are likely to slow down (AR5).

- Poleward shifts in the mid-latitude jets of about 1 to 2 degrees latitude are likely under RCP8.5 in both hemispheres, with weaker shifts in the Northern Hemisphere (AR5).
- The tropical Hadley cell is likely to widen, which translates to broader tropical regions and a poleward encroachment of subtropical dry zones (AR5).
- In the stratosphere, the Brewer-Dobson circulation which moves ozone from the tropics (a source region) to the poles is likely to strengthen (AR5).
- The global frequency of tropical cyclones will likely either decrease or remain essentially unchanged along with a likely increase in the global mean tropical cyclone maximum wind speed and rainfall rates. There is lower confidence in region-specific projections of frequency and intensity. But it is more likely than not that the frequency of the most intense storms will increase substantially in some basins (AR5).
- Substantial uncertainty surrounds projected changes in Northern Hemisphere storm tracks, especially for the North Atlantic. A small poleward shift is likely in the southern hemisphere storm track. Globally, the number of extra-tropical cyclones is unlikely to decrease by more than a few percent.
- There is medium confidence that the frequency of blocking in the Northern and Southern hemisphere will not increase, but there is low confidence in the trends in intensity and persistence of blocking events.
- Monsoons are important in a number of tropical regions. Areas encompassed by monsoon systems will likely increase over the 21st century, monsoon season will lengthen in many places and monsoon rain is likely to intensify (AR5). Inter-annual rainfall variability related to the monsoon will increase in future. Future increases in monsoon-related precipitation extremes are very likely in South America, Africa, East Asia, South Asia, Southeast Asia and Australia. It is now thought likely that the Asian summer monsoon season will lengthen and the region influenced by it will expand.
- The El Niño Southern Oscillation (ENSO) is the dominant natural mode of variability with far reaching consequences for the weather. This is very likely to remain the case and the related regional rainfall variability it causes is likely to intensify. Power (2013) found that there may be an intensification of El Niño driven drying in the western Pacific Ocean and rainfall increases in the central and eastern equatorial Pacific. Confidence in projected changes in ENSO over the century is low (AR5).

There is currently no understanding of the possible influence of increased greenhouse gases on Atlantic Multi-Decadal Variability and the Pacific Decadal Oscillation. Changes in these could be crucial for the rate of warming of the whole planet as well as for regional change.

v. Changing hazards under climate change

In the sections below the risks of individual weather hazards are discussed. For each source of risk, a general introduction mentioning the possible impacts of climate change on each phenomenon is given, and then climate change projections for 2100 are given.

Changes in the risk of flooding by 2100

An increase in intensity and frequency of heavy precipitation events is expected by 2100 (AR4, SREX, AR5). There are projected to be more intense storms and fewer weak storms (AR5). The general trend towards heavier rain should continue up to 2100 and this potentially leads to higher risks of fluvial or pluvial flooding.

Coastal flooding could become more of a problem. Under a “limited mitigation” scenario (RCP8.5), 45-81 cm of sea level rise is projected by 2081-2100 compared to 1986-2005 (AR5), with a range of 53 to 97cm for RCP8.5 at 2100. If there are very significant emissions reductions (RCP2.6), 26-54 cm of sea level rise is projected over this timescale. There is projected increased incidence and/or magnitude of extreme high sea level by 2100 (AR4, SREX, AR5). This increases the risk of damaging storm surges. The mean change in sea level will present more of a problem for low-lying regions such as Bangladesh.

Change in drought risk by 2100

Under a limited mitigation scenario, an increased risk of drought is likely in presently dry regions, linked to projected reductions in soil moisture. Soil moisture will decrease significantly (~7.5-10%) in the Mediterranean, southern Africa, N.E. South America, Central America, S.W. United States (AR5, TFE.1, Figure 2). There is a smaller (~2.5-7.5%) decrease projected (also with high agreement) in parts of Northern continental Europe (not Scandinavia) e.g. France, Germany and also in China (AR5, TFE.1, Figure 2).

Water availability

Water availability and drought/flood risk is an important issue for agriculture. There is more confidence in the projected changes in water availability on this timescale. There is expected to be an increased contrast between wet and dry seasons and regions with dryer regions becoming dryer and wetter regions becoming wetter (AR5). This means that the high latitudes and the equatorial Pacific will likely experience more precipitation and more runoff (AR5). On the other hand, many mid-latitude and subtropical arid and semi-arid regions will likely experience less precipitation.

There is a high level of agreement that the Mediterranean, southern Africa, and southern South America will get less precipitation by 2100 under a limited mitigation scenario (AR5 Figure TS.16). Decreases in river runoff are also expected in the Mediterranean, Middle East and southern Africa under RCP8.5 (AR5). These parts of the world are mostly already dry and a reduction in precipitation could have a significant impact.

In some parts of the world, glaciers are an important water source, smoothing out the variability in the water supply and in hydro-power. People in mountain regions could therefore be more vulnerable to seasonal water shortages as glacier decline under climate change. By 2100 15-55% of current glacier volume is projected to be eliminated under RCP2.6 and 35-85% under RCP8.5 (AR5). This risk would have to be assessed on a regional scale to get a better idea of the impacts.

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In low-lying areas of Bangladesh, salt water intrusion into drinking water aquifers is already a problem (Khan, 2011) and this could become more of a problem with rising sea levels and increased risk of storm surge.

Changes to the risk of heat waves by 2100

AR5 says that for high emissions scenarios, it is likely that most land regions will see at least a doubling in the frequency of current 1-in-20 year maximum temperature events. A current 20 year low temperature event will become very rare (AR5).

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Royal Society Call for Evidence on resilience to climate change

Suggested priorities for future enquiry relating to resilience of human health and health care systems to climate change.

This response is on behalf of 'UKDC-Resilience', a newly formed consortium of leading research institutes specialising in disaster resilience, located respectively at: University College London; Kings College, London; Durham University & Bristol University [1].

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*The following comments are intended as contributions on some **specific issues** pertinent to the questions set out by the Royal Society in their call for evidence. We have indicated which of the Questions we think our responses relate to and we have underlined some key areas where we think that future research may need to be concentrated to address these issues and help to improve human resilience to climate change.*

Q1 How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?

Q2 Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

One major impact of weather related hazards for human populations operates through the effects of extreme weather on health. Several overviews of evidence on this issue show, for example, that coldwaves, heatwaves and flooding are associated with excess mortality rates in human populations particularly among relatively vulnerable groups, such as older populations, and also with increased physical and mental illness (eg Ahern & Kovats, 2006); Ahern, Kovats, et al. ,2005; Kovats, 2008; Armstrong, et al. ,2010); Carroll, Morbey, et al. 2009; Tunstall, et al.,2006.Curtis and Oven,2011; Hajat, et al.,2004; Few & Matthies, 2006); Hajat et al. 2007; Knowlton, et al. (2009) Wilkinson & Pattenden, 2004; Curtis, 2010; Norris, 2005; Neria, et al, 2002).

Extreme weather also impacts on infrastructures that are important for many key functions for human societies including health and social care systems (Carthey & Chandra, 2007; Oven et al, 2012; Auld & Maclver, 2007; Michelozzo et al. 2009; Maheswaran et al., 2004)

In many countries globally, including the UK, the relative size of the older population is set to increase significantly, especially in the oldest age groups. Various other attributes of populations, in addition to age, are also important for vulnerability to climate change impacts such as extreme weather events. In the UK work is well advanced to assess local variation in vulnerability (Lindley et al., 2011; Cavan et al., 2010, 2011; Shah and Peacock, 1999). However, many of the available indicators relate to *current* vulnerability. Further research is required to explore how aspects of vulnerability are changing over time and to attempt to forecast what this may mean for future resilience to a changing climate. In many other parts of the world measurement of hazard and risk is less advanced. Especially important is evaluation of regional variation in hazard and vulnerability to identify the areas where resilience most needs to be developed.

A further aspect of uncertainty relates to the extent to which human populations (and infrastructure systems) may be able to adapt to extreme weather associated with climate change . Processes of adaptation are important for resilience and they partly explain the fact that the extreme events likely to produce impacts on human health vary geographically. Even within the UK, temperature levels triggering emergency response in the NHS (2010) heatwave plan vary from one region to another, reflecting regional variations in 'typical' conditions to which the population are accustomed. Internationally, adaptation varies more widely (Laake & Sverre, 1996; Curriero et al., 2002; McKee, 1989 Pelling 2011). The topic of adaptation has been the focus of a research programme on *Adaptation and Resilience to Climate Change*, sponsored by EPSRC and the projects funded under that programme are still producing evidence and research briefings that are helping to frame the forward research agenda in this field <http://www.arcc-cn.org.uk/> (See also:Carson, et al., 2006; Oven et al. 2012).

Further research is needed to understand and predict the complex combinations of extreme weather conditions producing impacts for human health which may involve 'cascading'

processes which are difficult to model, especially at geographical scales relevant for effective resilience planning. For example, periods of extreme heat or cold over several days have been shown to present the most severe health risks for these groups. These are difficult to forecast accurately, especially over the long term and at a sufficiently fine scale to inform local resilience (Kharin & Zwiers, 2005). An example of research to apply the latest UKCIP weather generator to estimation of risks in 2030, at the scale of a 50km grid and based on a medium emissions scenario period 2020-2049 is reported by (Owen et al, 2012). Further analysis by these authors (details available on request) shows that use of different scenarios would significantly affect the outcomes of these models. Jones et al (2012) also report on estimation of extreme rainfall risk. There is significant uncertainty in projection models predicting local scale, long range trends that are important for future resilience planning. *There is a need for future research and technical developments to address the challenges of long range forecasting of risks of extreme events for local areas.*

Q 3 What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

Q4 Who are the real adaptation decision-makers / where are adaptation decisions really made?

Resilience is a complex phenomenon Cutter et al. (2008) and does not equate simply to the inverse of vulnerability. Indeed populations may show high levels of both vulnerability and resilience. Studies suggest (eg Pelling, 2010, Wistow et al, 2013; Curtis et al, 2013) that local structures and self organization within communities are essential elements of resilience to climate change. At the same time, larger scale systems are very important for building resilience.

Climate change resilience is a pressing social and political issue in the UK and internationally (Pelling et al., 2011). Action at the level of international and national government agencies is vital but so is response at the local scale.

At national level in the UK Guidance produced by NHS Sustainable Development Unit (*Adaptation to Climate Change for Health and Social Care Organizations 'Co-ordinated, Resilient, Prepared'*, 2013) indicated a range of features of good adaptation plans to make health services more resilient to climate change. These include strategies which are: embedded in a comprehensive sustainable development management plan at LA level, developed in partnership with the range of stakeholders who need to be involved and are reviewed and updated. The DEFRA National Adaptation Plan 2013 also emphasizes that '*The Health and Social Care Act 2012 and the Civil Contingencies Act 2004 require NHS and NHS-funded care providers to ensure that they manage risks to the continuity of health and social care service provision, including from severe weather events and the associated increased demand.*' The Health Protection Agency (now Public Health England) and the Cabinet Office have also stressed the need for enhanced local preparedness for extreme weather events to ensure resilience of health care systems. Internationally WHO (2012) and UN-ISDR (2002) underline related issues.

The future research agenda relates to how to most effectively develop local preparedness for extreme weather events, both in the UK and internationally, as part of a wider and larger scale programme of action.

Q5 What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

Among the important toolkits available are those relevant for local planning and adaptation to climate change. Within the UK, considerable progress has been made to assist local actors example in identification of local populations most vulnerable to climate change, coordination and collaborative development of local resilience [see list of examples at note 2]. The next generation of research will need to assess and evaluate the impact of these on local strategic planning and practice.

Footnotes

[1] Research Institutes in the UKDC-Resilience consortium:

University College London Institute for Risk and Disaster Reduction <http://www.ucl.ac.uk/rdr/>

Kings College Natural Hazards, Disaster Risk Management and Climate Change Adaptation <http://www.kcl.ac.uk/sspp/research/cirrr/Disaster-and-Risk/About.aspx>

Durham University Institute for Hazard Risk and Resilience <https://www.dur.ac.uk/ihrr/>

Bristol University, Cabot Institute <http://www.bris.ac.uk/cabot/>

2] Examples of local adaptation tools to build resilience to climate change.

- Lindley, S. et al. (2011) climate change: social justice and vulnerability <http://www.jrf.org.uk/publications/climate-change-justice-and-vulnerability>
- BIOPICCC Toolkit (Built Infrastructure for Older People's Care in Conditions of Climate Change): <https://www.dur.ac.uk/geography/research/researchprojects/biopiccc/toolkit/> ;
- Climate Ready – link to Health and Well-being: 'Adaptation Wizard' though: (<http://www.environment-agency.gov.uk/research/137619.aspx>);
- Climate Local. 'Menu of actions and commitments' http://www.local.gov.uk/c/document_library/get_file?uuid=59198810-739e-48fc-beb8-c705cb1d384a&groupId=10171
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Questions/Answers

1. How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?

Ad a) (2030) We can expect rather more frequent singular extremes of weather than overall shift of temperature or precipitation. It means that the frequency and intensity of hazardous events will grow for all main types – floods (especially flash floods) and droughts; heat and cold waves, storms. An example of such events is flooding in central Europe in 2002, followed by drought in 2003.

The location of drought will extend northwards, including forest fires

Ad b) 2100 the trend will probably continue, but it is more difficult to predict. Due to the growing human population, drought will be more important phenomenon.

2. Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

Depends on location. In semi-arid and arid areas it is drought, in Central Europe floods. The adaptation and preparedness is more probable to flooding, as illustrates example of series of floods in Czech Republic between 1997 and 2013, where the vulnerability is now lower (smaller impacts). Calculated by number of deaths, for Europe the highest fatality shows heat wave, but we can discuss, how to compare impacts of heat wave (fatalities of people with rather short life expectancy) and other events (average population)

3. What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

- Readiness to change (flexibility)
- Pro-active approach
- Thinking in long-term dimension
- Readiness to invest instead to consume

4. Who are the real adaptation decision-makers / where are adaptation decisions really made?

Real adaptation happens at local level – individuals, families and communities. Government may help by clear adaptation-oriented policy, providing information and education and in the cases of serious events.

5. What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

No idea

6. What are the most commonly discussed and implemented adaptation approaches for protecting against, reducing sensitivity to, and allowing recovery following, weather-related hazards?

- Land-use planning
- Societal cohesion
- Landscape stability support
- Infrastructure resilience

7. Are there any studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?

I have no such information

8. To what extent, and under which circumstances, can ecosystem-based approaches be integrated with other adaptation approaches (eg. those that involve hard infrastructure, technology and social interventions)?

Theoretically to the full extent, but it would demand the willingness to accept modest way of life and probably to abandon the idea of permanent growth.

9. In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?

- Flexibility
- Complexity
- Sustainability
- Appropriate time-scale
- Socio-economical acceptability
- Feasibility

10. To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?

The resilience is in the principle ecosystem-based approach and contemporary is for example by United Nation's International Strategy for Disaster Reduction (UNISDR) the resilience one from key priorities in (natural) disaster risk reduction (e.g. 4th meeting of EFDRR at Oslo, 2013)

11. What are the appropriate scales for, constraints, distributional consequences and trade-offs of ecosystem-based approaches?

I do not feel to be able to answer properly

Human resilience to climate change and disasters

DFID contribution to a Royal Society Enquiry¹

Introduction

1. This document sets out DFID's contribution to an enquiry by the Royal Society² on human resilience to climate change and disasters. Its main focus is on clarifying DFID's experience, how decisions are made and where the main knowledge gaps are.
2. Improving human resilience is an important component of DFID's mission. Core responsibility for *disaster resilience* is vested in the Conflict, Humanitarian Assistance and Security Department (CHASE). Policy Division's Climate and Environment (CED) and Growth and Resilience (GRD) departments focus on *climate change and resource scarcity*.
3. Details of the department's priorities are elaborated in the Coalition Government's departmental business plans³.
 - The main deliverables on disaster resilience are part of the government's aim to '*Improve the effectiveness of UK and international humanitarian response and preparedness*', namely: '*To build disaster resilience in all DFID programmes as committed in the UK response to the Humanitarian and Emergency Response Review (HERR)*'
 - Climate change deliverables include a number of actions to '*Support developing countries' climate adaptation and low-carbon growth*', through actions supported by the International Climate Fund (ICF⁴), and '*Make DFID more responsive to climate change and resource scarcity* by ensuring that '*climate change risks and opportunities are identified and addressed across DFID's country programmes and other major policy and spending areas*'.
4. DFID's approach to assisting developing countries to build resilience to disasters and climate change is to provide *dedicated programme funding* to targeted resilience / adaptation activities where this is seen as a local priority, as well as *mainstreaming* resilience across its entire portfolio.
5. The contribution to this enquiry is organised around 6 core questions agreed between the Royal Society and DFID. The list of questions can be found in Appendix 1.

¹ Yvan Biot, Annika Olsson, David Howlett, Tim Waites, Simon Lucas, Matthew Greensdale, Jane Petty and Ken DeSouza. Approved by Tim Wheeler.

² <http://royalsociety.org/policy/projects/resilience-climate-change/working-group/>

³ <http://transparency.number10.gov.uk/business-plan/12>

⁴ <https://www.gov.uk/government/publications/aims-and-objectives-of-the-international-climate-fund-and-capital-markets-climate-initiative>

Question 1: How does DFID make decisions about what types of climate change adaptation / DRR to fund?

6. Decisions about what to fund in climate change adaptation and DRR follow the same process as in any other area of DFID's business. This involves *policy* decisions about overall objectives, approaches and sectoral / regional resource allocations, *operational* decisions about portfolio priorities by country offices and other business units and *implementation* decisions at point of delivery.

ICF strategy - adaptation

7. The vision for the UK's approach to adaptation is that "*vulnerable people in poor countries are prepared and equipped to respond effectively to existing climate variability and the magnified impacts of climate change*". Priority actions on adaptation are set out in the ICF Thematic Paper on Adaptation (March 2011), under the following headings:

- Develop the building blocks for adaptation – knowledge, capacity, institutions and evidence;
- Scale-up delivery of adaptation programmes in key vulnerable sectors – testing new programmes, identifying low regrets options, high co-benefits projects; and .
- Supporting the development of an effective national and international climate architecture to deliver adaptation financing.

8. Adaptation actions are supported in a set of priority countries and regions, with bilateral interventions in countries where DFID has an established presence, and through multilateral channels where there is no established presence. Priority is given to countries with high vulnerability and capacity to act, with engagement tailored according to levels of vulnerability and capacity. Priority sectors include agriculture, DRR, water, urban, coastal zones, social protection and health.

Mainstreaming adaptation into development

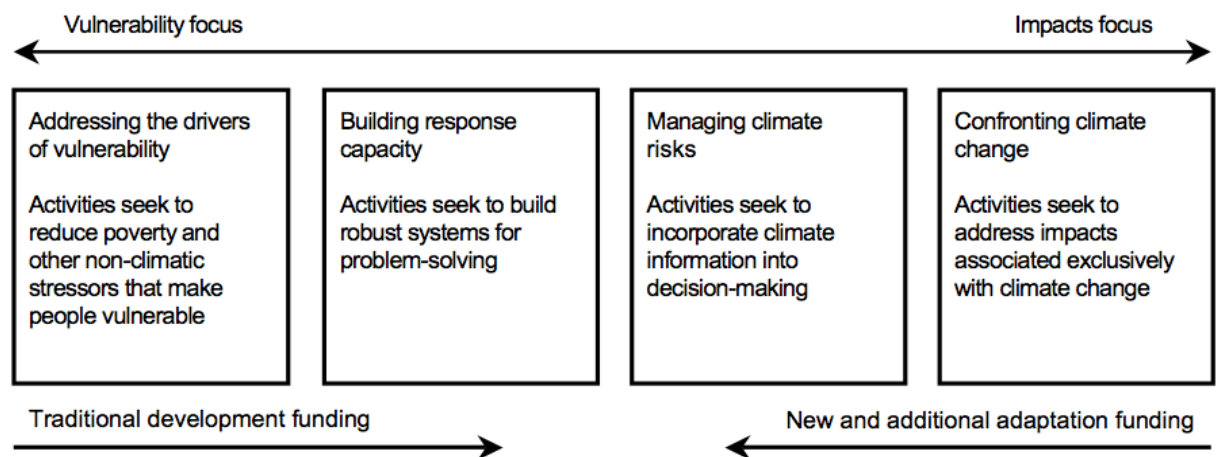
9. A second component of DFID's approach to helping developing countries build resilience to climate change is to mainstream adaptation across its development portfolio. Departmental priorities and organisational capability in this area are under development through 2 organisational change processes at the level of the organisation as a whole (*'Future Fit'*) and individual business units / country offices (*'Strategic Programme Reviews'*).

10. Figure 1 sets out the spectrum of activities that are funded by both the ICF and DFID's core development budget, which range in emphasis from reducing vulnerability to dealing with specific climate impacts⁵. Much of DFID's

⁵ Adapted from Klein and Persson (2008) *Financing Adaptation to Climate Change: Issues and Priorities* European Climate Platform Report No 8, October 2008; and McGray, H. et al (2007)

core development work naturally falls into categories 1 to 3 on the spectrum. Human development programmes will largely fall into category 1; governance, capacity, and institution building work into category 2; and disaster risk reduction, humanitarian, and natural resource management programmes (all of which take current climate variability into account) will fall into category 3. Programmes funded under the ICF are designed specifically to deal with the additional costs caused by a changing climate, and mainly fall into categories 3 and 4.

Figure 1



Helping countries protect themselves against future disasters

11. The department's approach to helping countries protect themselves against future disasters is set out on the government website⁶ and is based on an assessment of the geography of poverty and vulnerability as recently published by a DFID commissioned ODI report⁷. The aims are to embed resilience in all DFID country programmes by 2015, building on current activity and capacities and tailored to the country context.

12. This is being done to a defined minimum standard⁸ and started last year with a focus on the 16 countries most at risk⁹. The first step for each country is to develop a Multi Hazard Disaster Risk Assessment (MHDRA - guidance note, attached). This identifies the risks and hazards, maps out who are vulnerable, the nature of their vulnerability, assesses the capacity of the government and other stakeholders to respond, an assessment of projected impacts and finally, what the DFID office is already doing in disaster resilience/ DRR.

Weathering the Storm, Option for Framing Adaptation and Development World Resources Institute 2007.

⁶https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/186874/definining-disaster-resilience-approach-paper.pdf

⁷ <http://www.odi.org.uk/publications/7491-geography-poverty-disasters-climate-change-2030>

⁸ See guidance note attached

⁹ See also examples from Nepal and Kenya

13. During the process, relevant line ministries and a broad number of development partners are consulted, secondary data analysed and discussions facilitated across teams in the office to identify where there is related work to build on. In high risk countries, the MHDRA analyses natural and man-made risks and disasters and attempts to integrate climate modelling. It also aims to be informed by the political economy, government development policy and strategies and institutional barriers and accelerators. The MHDRA is used to inform the office's disaster resilience strategy, one of the key tools for deciding future programmes.

Making decisions about what to fund at project level

14. Specific decisions about what types of activity to fund are primarily based on partner government strategies and priorities, as reflected in countries' Hyogo Framework¹⁰ Action Plans and National Adaptation Plans and related strategies.

15. Once an area of support has been identified a business case is made, which relies on a review of the relevant literature, especially about the nature and importance of the problem and about 'what works and what doesn't' (see next section for details); experiential learning (ie: derived from former investments or similar investments elsewhere); knowing what others are doing and DFID's comparative institutional advantages in the region.

16. DFID's business case rationale follows guidelines set out in HMT's Green Book and involves a number of stages:

- *Setting out the rationale for public action:* an important first step is to understand whether the problem to be addressed would be solved by the private sector without public support to ensure that any public action and spending would be additional to the outcome in its absence;
- *Option identification:* a range of options should be considered, ranging from policy changes (e.g. could the problem be avoided through regulation such as planning controls in flood plains, or pricing such as environmental taxes) to a solution requiring public expenditure;
- *Option appraisal:* a process which asks whether the benefits of a public intervention are likely over time to exceed the costs compared both with not intervening and with other options. A range of economic techniques are used for this appraisal depending on the extent to which the benefits can be quantified or not.

17. A mandatory climate and environment appraisal process helps identify key project vulnerabilities to climate shocks and trends and entry-points for adaptation and disaster risk reduction action across the full range of DFID investments. The process identifies risks from the wider environment,

¹⁰ <http://www.unisdr.org/we/coordinate/hfa>

including climate, on intended project activities and from project activities on the wider environment. It also aims to identify opportunities for positive action.

18. Making decisions about climate adaptation and resilience involves dealing with uncertainties about future climatic conditions, human vulnerability and adaptive capacity. A number of tools have been suggested by the academic literature to address uncertainties in decision making, which have recently been laid out in a technical 'How To Note (HTN)' on decision making under uncertainty¹¹. A programme is being developed to test the usefulness and comparative strengths and weaknesses of these tools.

Decision support tools

19. A number of decision support tools have been developed and used ever since DFID scaled up its work on climate adaptation and resilience and this work is continuing under the umbrella of the department's *Future Fit* programme. These include, amongst others, climate risk assessments (CRA's) of country investment portfolios in Bangladesh, India and Kenya, which were used to develop and test the ORCHID¹² approach to portfolio risk assessment.

20. Current work is focused on developing decision support tools in the area of adaptation, carbon prices, resource scarcity and valuing the future (discount rates, ...). The decision support tools that will be developed under this *Future Fit* work-stream are targeted at specific decision making pathways and moments. This includes global policy making, country context analyses conducted to direct country expenditure (Box 1) and project design. The Climate and Development Knowledge Network (CDKN), a DFID and Dutch government funded knowledge sharing initiative on climate compatible development, has developed a useful site¹³ that allows users to select decision support tools that are tailored to their specific needs.

Box 1: Assessing the resilience context of DFID country programmes

Understand the context: Highlight key risks to growth and poverty reduction from:

- Major shocks (e.g. natural disasters, global financial shocks, extreme weather, climate change). What events exceed the country/community's coping capacities?
- How sensitive are the country's development pathways to those? E.g. is growth natural resource dependent, vulnerable to market fluctuations or disasters?
- What sections of the population are most vulnerable?

Scenarios: Look at the future and assess likely changes to risk, sensitivity and exposure: for example:

- What may happen to climate, natural resources (land, water, energy, forests, fisheries)?
- How might these future risks affect the prospect for growth, conflict and the

¹¹ See attached How To Note

¹² <http://www.ids.ac.uk/climatechange/orchid>

¹³ <http://www.climateplanning.org/>

political settlement?

- Do structural trends in the economy and poverty reduction system suggest they are becoming more or less exposed?

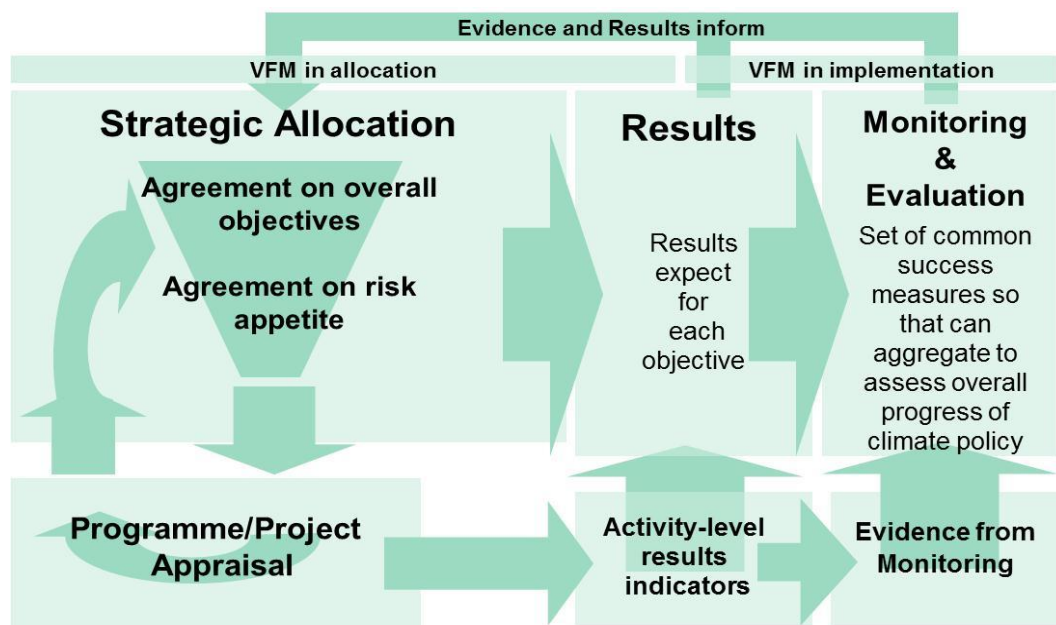
Adaptive Capacity: Assess the capacity (and willingness):

- of the economy and local livelihood systems to cope with shocks and address long term trends (e.g. the diversification of growth drivers away from climate sensitive sectors);
- of state and non-state actors to respond to major shocks (consider the disaster management system - preparedness, risk reduction and response),
- of state and non-state actors to address long-term threats (e.g. climate change, unsustainable water extraction, land degradation) and deliver integrated adaptation.

Assessing value for money

21. VFM is an important consideration at all levels of decision making. Figure 2 sets out the approach to measuring and securing value for money from the ICF portfolio.

Figure 2: Securing VFM as an on-going process in the ICF



22. In this portfolio, VFM in allocation is secured by ensuring that resources are allocated in line with clear strategic objectives and with the appropriate risk profile. These are set out in the ICF Thematic Paper on Adaptation (March 2011), which is based on the best available evidence at the time. The strategy includes guidelines on priority counties, types of activity and sectors. The paper also recommends a specific focus on “low regrets” adaptation options.

23. We are currently improving our knowledge on how to sequence and prioritise adaptation interventions (such as low regrets options) and improving our ability to measure improvements in resilience in order to maximise value

for money. More information on these research programmes is provided under Question 6. VFM in implementation of ICF adaptation investments is also considered during programme design and on an on-going basis through programme monitoring and evaluation. Evidence and results will inform improved allocative efficiency of future programming.

Question 2: What evidence does DFID use / require both before deciding to fund a project and during project implementation

24. The business case development process requires that specific, evidence be presented to justify the intervention proposed and the way that it will be delivered, including:

- Description of the nature and causality of the problem to be addressed;
- Effectiveness of proposed actions;
- Rationale and underlying assumptions of the ‘theory of change’;
- Costs, benefits and value for money;
- What was learnt from past and on-going experiences elsewhere;
- What others are doing.

25. Business cases are required to assess the overall strength of the evidence referred to, especially as regards the choice of option, and explain how the strength of the evidence about ‘what works and what doesn’t’ is considered in the proposed activities. Details about assessing the strength of the evidence are set out in a dedicated ‘How To Note¹⁴’. Top of the range include systematic reviews and rigorously designed and peer reviewed (policy) impact evaluations.

26. An example of how DFID uses evidence in the design of its programmes is the Building Resilience and Adaptation to Climate Extreme and Disasters (BRACED) programme¹⁵. The example illustrates how DFID uses the latest evidence available to identify challenges and what actions are needed to address these. The options for BRACED were subject to a full economic appraisal to determine what types of interventions it should support, and how best to deliver these interventions.

27. Evidence needs during project implementation are predicated upon the projects’ monitoring and evaluation requirements set out in the business case, the strength of which is governed, in part, by the strength of the evidence in support of the proposed course of action. At a minimum level, projects are required to collect information that will assist the annual progress review process¹⁶, which is based on projects’ agreed delivery plans as laid out in the project’s Logical Framework¹⁷. In cases where the evidence for effective delivery is weak, a programme may opt for a parallel, independent impact evaluation process, which will test core assumptions in the theory of change.

28. Projects are also required to provide evidence about delivery against core policy objectives, as defined by key performance indicators (KPI’s). Work on better measurement of KPI’s in both disaster and climate change resilience programming is still on-going¹⁸. Current success indicators for the adaptation window of the ICF include the extent to which a project has managed to

¹⁴ See attached How To Note

¹⁵ See attached document

¹⁶ See attached format

¹⁷ See attached example

¹⁸ Drafts available on request

improve the level of a country's or community's knowledge of climate change issues, increase the number of people able to cope with the effects of climate change and increase the number of jobs. Proposed disaster resilience KPI's include attempt to measure the extent to which a project or programme manages to:

- Reduce or eliminate exposure of vulnerable household's to shocks and stresses;
- Decrease disaster related mortality;
- Safeguard Livelihoods and minimise the impact on household income and expenditure/consumption;
- Protect the social welfare of households;
- Households are aware of disaster risks, and early warning systems and know what to do in the face of a shock or stress;
- Improve the capacity of government systems to manage both risks and the response to shocks and stresses effectively.

29. Climate adaptation and, to a lesser extent DRR¹⁹, suffer from a dearth of evidence about what works and what doesn't, costs and benefits and value for money. Defining success criteria for 'additional adaption' – i.e.: actions that build resilience to the impacts of climate change, over and above the impacts of current climate variability – is still an embryonic and contested area of enquiry, partly controlled by the political processes that unfold under the umbrella of the UNFCCC. This is why DFID focuses a significant part of its pure and policy research investments on characterising and measuring resilience – including via support to CARIAA²⁰ and TAMD²¹.

¹⁹ See, for instance, the review of The Economics of Early Response and Resilience available from <https://www.gov.uk/government/policies/helping-developing-countries-deal-with-humanitarian-emergencies/supporting-pages/helping-countries-protect-themselves-against-future-disasters>

²⁰ http://www.idrc.ca/EN/Programs/Agriculture_and_the_Environment/CARIAA/Pages/default.aspx

²¹ <http://www.iied.org/tracking-adaptation-measuring-development>

Question 3: Social protection – how is this deployed and how is success measured?

30. Social protection can be a good value for money option for reaching the poorest – see 2011 National Audit Office report and 2012 Public Accounts Committee report on cash and asset transfers^{22, 23}. Programme design can vary and depends on outcome objectives. Objectives are typically poverty reduction, food security and human development. But building household and local assets, and therefore resilience, may also be an objective.

31. Two examples of where DFID supported social protection programmes have had an impact on household assets and resilience are:

- *The Productive Safety Net Programme in Ethiopia*, which DFID supports with other donors including the World Bank.²⁴ Over the period 2004-2010, asset levels of beneficiary households showed a steady increase and distress sales declined (see attached evaluation).
- *The Challenging the Frontiers of Poverty Reduction Programme in Bangladesh*, which increased the value of livestock assets owned by households by some 12 times.²⁵

32. To measure the success of DFID-supported social protection programmes independent quantitative evaluations are standard. This was highlighted in the 2011 National Audit Office report, which stated that '*Evaluations generally used comparisons against groups not receiving the transfers, which gives better evidence on results and attribution than we have reported on the Department's other work*' (paragraph 8).

33. CHASE is interested in the use of national led social protection and safety net programmes as a first responder to slow-onset disasters such as drought. Risk Financing Mechanisms, acting as contingency funds, can release funding to enable the social protection mechanism to add more beneficiaries, or increase the length of time of the transfer, or increase the size of the transfer to stop households selling their assets.

34. There is a strong theoretical case for social protection as a vehicle to build resilience to both short and long term shocks and change:

- Public works projects have the potential to improve the local environment while providing social protection. In Ethiopia, the PSNP

²² NAO (2011) *Transferring Cash & Assets to the Poor*. Report by the Comptroller and Auditor General, HC 1587 Session 2010-2012, 9 November. National Audit Office, London. Available at <http://www.nao.org.uk/report/dfid-transferring-cash-assets-to-the-poor/>

²³ PAC (2012) *Transferring Cash & Assets to the Poor*. House of Commons Committee of Public Accounts, Sixty-fifth Report of Session 2010–12, London, 3 February. Available at <http://www.parliament.uk/business/committees/committees-a-z/commons-select/public-accounts-committee/news/dfid-report-/>

²⁴ See NAO report above and also World Bank web site <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:21072837~menuPK:1804110~pagePK:146736~piPK:146830~theSitePK:258644,00.html>

²⁵ NAO report paragraph 7.

supports soil and water conservation through public works (cash for work). Essentially this makes the PSNP one of the largest environmental management programmes in Africa and demonstrates how a social protection system could build climate resilience.

- In Rwanda, the Vision 2020 'Umurenge' Program's public works projects have put in place erosion control channels and terracing to prevent run-off, maintain soil fertility and increase the area of land that can be farmed helping farming households adapt to climate change.

35. A key opportunity associated with social protection programmes is their ability to be scaled up in times of emergency to act as a short term safety net for people likely to be affected by extreme conditions. There is evidence that early response is more cost effective in predictable emergencies than delaying responses until the situation is desperate and a national mechanism that can support such a response is far more efficient than launching large scale humanitarian responses (see footnote 17). In regions of protracted crisis (like the Sahel or the Horn of Africa) and cyclical weather extremes the value of such systems is significant.

36. While the theoretical case and anecdotal evidence for social protection as a resilience building intervention are strong, the evidence base is still weak. Davies, *et al.* (xxxx)²⁶ explored the concept of adaptive social protection and concluded that evidence is particularly weak on how to combine social protection measures to mitigate vulnerability to climate change in different contexts. DFID hopes to build the evidence base through the adaptive social protection and BRACED²⁷ programmes in the Sahel²⁸.

²⁶ Davies, M, Oswald, K and Mitchell, T, 2009: Climate Change Adaptation, Disaster Risk Reduction and Social Protection. In: Promoting Pro-poor Growth: OECD – IDS – P209

²⁷ <https://www.gov.uk/building-resilience-and-adaptation-to-climate-extremes-and-disasters-programme-braced>

²⁸ See attached *draft* evidence paper in support of WB Sahel programme for further details

Question 4: phased interventions – how is the most appropriate phasing identified and how does this approach work in practice?

37. Building resilience to long term trends requires some knowledge of the range of future risks to consider; however, this is often limited and evolving. The implications of an ever changing and evolving knowledge base with regards to adaptation planning are that early investments have a large risk of failure and should therefore be kept to a strict minimum, have a high probability of delivering co-benefits (see last section) and allow for adjustments at a later stage. This supports a phased approach to adaptation, as illustrated by the Thames Estuary 2100 project²⁹.

38. DFID's decision making process allied to its strong emphasis on evidence-based decision making incentivise cautious investments where the evidence base is weak for particular causes of action. Appropriate actions in such situations include: preliminary investments to improve the evidence base, scoping and pilot activities. In cases where actions are dependent on the outcome of preliminary investigations and testing, this is built into project design and delivery, with review points earmarked from the beginning.

39. The Building Resilience and Adaptation to Climate Extreme and Disasters (BRACED) programme is planned in two phases over seven years, recognising that building resilience to extreme weather events is a long term process. The first phase will support and then scale up pilot actions by consortia led by NGOs in countries in the Sahel and other regions at risk from extreme events. This phase is accompanied by a significant research and evaluation component to learn what types of interventions are best at delivering resilience. The second phase will look to use these lessons in the design of new programmes to be supported by DFID and others.

²⁹ http://www.environment-agency.gov.uk/static/documents/Leisure/SE_TE2100_briefing.pdf

Question 5: How does DFID use local information to understand how the climate might be expected to change at the project level, and hence to understand what type of intervention is most appropriate

40. DFID's programmes in support of developing country adaptation and long term climate risk mitigation actions are tailored to the specific circumstances of the target region and population. Where local action is supported, three principles usually guide activities: (i) start by considering current risks and approaches to mitigate those risks; (ii) use down-scaled climate scenarios to get an idea of the envelop of possible futures and test the resilience of current risk mitigation strategies, using a variety of tools³⁰ and (iii) rely on tested local knowledge and use community based development approaches to define what action is most suited to each particular environment.

41. These principles have been illustrated in the various actions supported by the DFID/IDRC Climate Change Adaptation in Africa (CCAA) project³¹. The recently selected consortia in CCAA's follow-on project, the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA)³², which aims to build a stronger evidence base on vulnerability and resilience building in heavily populated and vulnerable semi-arid, coastal and glacial floodplain areas, will use statistically and dynamically downscaled simulations complemented by district-level case studies and tailored climate scenarios that are site and question specific'.

42. The Building Resilience and Adaptation to Climate Extreme and Disasters (BRACED³³) programme will be providing grants to NGO led consortia to undertake locally specific actions to build resilience to climate extreme events (especially floods and droughts). In undertaking these interventions all consortia are expected to assess current and future climate risks, and to use the latest available evidence. These will vary and are expected to include community based adaptation and planning to investments in infrastructure and early warning systems.

³⁰ R. L. Wilby, J. Troni, Y. Biot, L. Tedd, B. C. Hewitson, D. M. Smith and R. T. Sutton, 2009: A review of climate risk information for adaptation and development planning *Int. J. Climatology* DOI: 10.1002/joc.1839

³¹ See, for instance, CCAA's approach to resilience building in Tanzania:

<https://www.gov.uk/government/case-studies/dfid-research-adapting-to-climate-variability-and-climate-change-in-tanzania>

³²http://www.idrc.ca/EN/Programs/Agriculture_and_the_Environment/CARIAA/Pages/default.aspx

³³ <https://www.gov.uk/building-resilience-and-adaptation-to-climate-extremes-and-disasters-programme-braced>

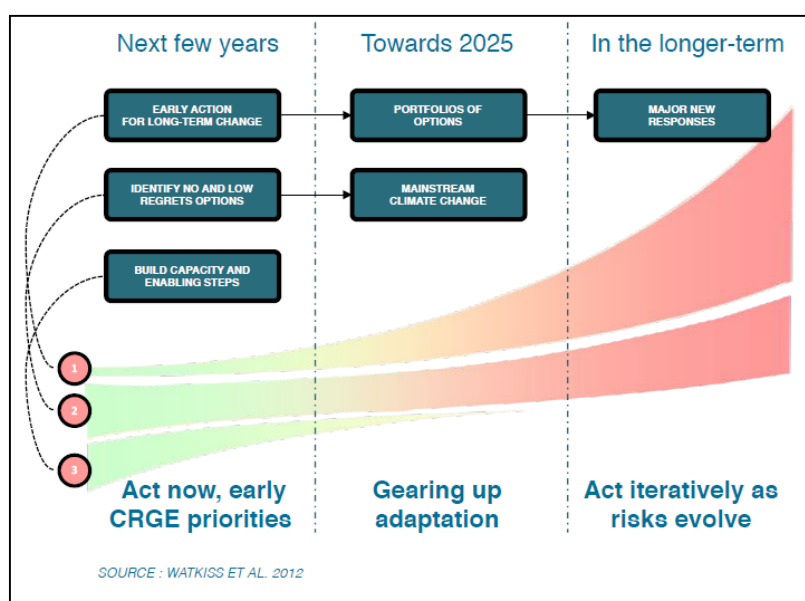
Question 6: how does DFID consider and promote 'low regrets' adaptation measures

43. A central question in decision making about adaptation concerns how to prioritise options, given limited climate and overseas development assistance (ODA) resources.

44. Supporting adaptation activities that have a positive development outcome are of particular interest because of DFID's core mission and uncertainties about the future. Such actions are traditionally referred to as 'no-regrets' or 'low-regrets'. However, the evidence on what such 'low-regret' actions look like and how to prioritise them is limited.

45. Early findings from a policy-research initiative on 'no regret' adaptation actions³⁴ highlight the difficulties involved. As explained above, uncertainty about the future points to the need for a flexible, evolving – or adaptive – management strategy, starting with 'soft' or non-technical options, before embarking on heavier investments in significant infrastructure (if at all necessary). Figure 3 illustrates the concept.

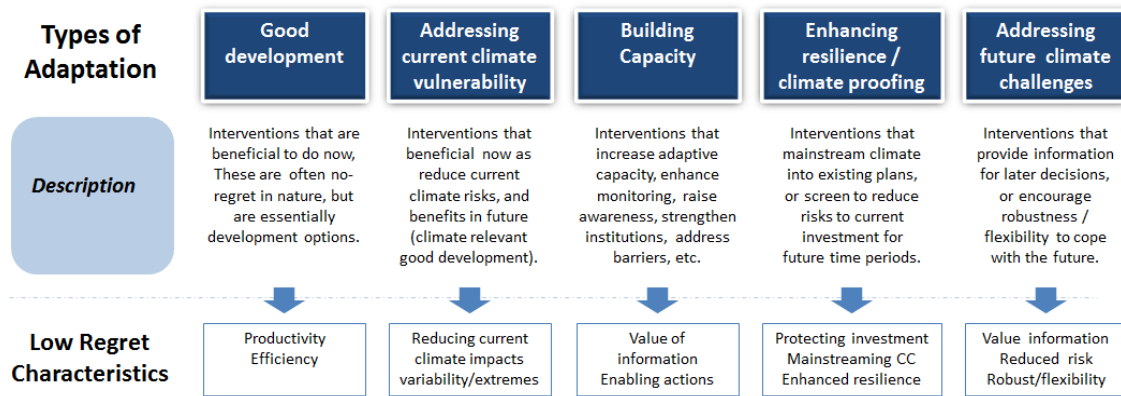
Figure 3: Adaptive management in an uncertain future



46. The study so far has produced a draft literature review about definitions and use of low regrets adaptation and designed a conceptual framework for further analysis. A draft typology of early adaptation options that are potentially no- or low-regret has been developed, which explores 'low-regret' characteristics with a view to developing guidance on how to assess them. The typology adopted is represented in figure 4 and follows closely the principles laid out in figure 1.

³⁴ See attached *draft* reports

Figure 4: Typology of adaption options



47. The next step is to develop and test a decision tool that will help DFID and the wider adaptation planning community identify early options that have high value for money. The decision tool will use the early actions typology to ask questions about local context that will be necessary in the identification, design, prioritisation and sequencing of adaptation options.

Appendix 1: Enquiry questions

Who are the real adaptation decision-makers / where are adaptation decisions really made?

What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

Main enquiry questions

1. How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?
2. Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?
3. What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?
4. Who are the real adaptation decision-makers / where are adaptation decisions really made?
5. What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?
6. What are the most commonly discussed and implemented adaptation approaches for protecting against, reducing sensitivity to, and allowing recovery following, weather-related hazards?
7. Are there any studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?
8. To what extent, and under which circumstances, can ecosystem-based approaches be integrated with other adaptation approaches (eg. those that involve hard infrastructure, technology and social interventions)?
9. In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?
10. To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?
11. What are the appropriate scales for, constraints, distributional consequences and trade-offs of ecosystem-based approaches?

Specific questions to DFID

1. How does DfID make decisions about what types of climate change adaptation/DRR to fund?
2. What evidence does DfID use/require both before deciding to fund a project and during the project (to ensure that it is yielding benefits on the ground)?
3. Social protection – how is this deployed, and how is success measured?
4. Phased interventions – how is the most appropriate phasing identified, and how does this approach work in practice?
5. How does DfID use local information to understand how the climate might be expected to change at the project level, and hence to better understand what type of intervention is most appropriate
6. Further details on the 'low regrets' piece of work commissioned by DFID adaptation team.



BUILDING RESILIENCE IN KENYA

Summary

The Horn of Africa Crisis in 2011 highlighted the vulnerability of poor people in the marginalised arid and semi-arid lands of northern and eastern Kenya to environmental, security and market shocks and stresses. DFID Kenya is investing in medium and long-term programmes to strengthen the ability of vulnerable households to withstand such shocks. To achieve this also requires these programmes to be able to flexibly respond to sudden spikes in need, which occur on a regular basis.

Context

The arid and semi-arid lands of Kenya are among the poorest parts of the country. For example, 94% of people in Turkana live below the national poverty line. People are extremely vulnerable to shocks and stresses, including frequent drought events. They are routinely food insecure and rates of acute malnutrition regularly rise above emergency thresholds, becoming particularly severe when there are environmental, market or security shocks.

Country specific challenges

Pastoralism is historically the traditional livelihood of people in the arid and semi-arid lands and is well-adapted to the climate. However, due to population and land use pressure, asset depletion linked to climatic and other shocks and inappropriate development interventions, many have started to abandon pastoralism as a way of life and settle in peri-urban areas with few livelihood opportunities.

The arid and semi-arid lands are chronically underdeveloped. Many aid programmes have historically focused on short term emergency aid, which has done little to increase the population's resilience to disaster. Over recent years there has been some increase in longer term drought management activities and the development of social safety net programmes, but there still remains a reliance on short term emergency assistance. This is scaled up in spike years, but is often too late.

What is needed is more medium and long-term investment to strengthen the ability of vulnerable households to withstand shocks and stresses, whilst also integrating the ability to respond to predictable future spikes in need from within these longer term programmes.

UK response

DFID is supporting the Government of Kenya's strategies to "End Drought Emergencies" and build resilient households in the arid and semi-arid lands by increasing the links between the delivery of social services, disaster risk reduction, livelihood investments, social protection, emergency response, and creating the conditions for economic growth. This requires:

- flexible funding for early response on the basis of credible early warning;
- strengthening public and household assets to build better coping and adaptive livelihood strategies;
- supporting the private sector to create opportunities and stimulate growth; and
- creating institutions and agencies in national and local government that can deliver services to poor people in accountable and transparent ways.

DFID is responding to these needs through the following programmes.

The existing **Hunger Safety Net Programme (HSNP)** is at the core of DFID Kenya's resilience work and already reaches 420,000 of the poorest people in the arid lands with regular cash transfers. This is improving food security, helping people to keep hold of their assets during shocks and allowing better access to health and education services. In the proposed £118 million **HSNP Phase II**, which is currently under design, the number of beneficiaries will increase to 890,000.

Whilst HSNP provides the safety net for households, the new £14.3 million **Arid Lands Support Programme (ASP)** which is currently under design, will support the resilience of some 475,000 people. The programme will involve: the expansion of a pilot Index Based Livestock Insurance mechanism for poor pastoralists; support to community destocking in advance of a drought; improved fodder production and storage; support to government veterinary service delivery; and the building of community assets, such as water storage.

The cost effectiveness of this approach has been highlighted in the DFID funded Economics of Early Recovery and Resilience Study, which showed that every \$1 spent on disaster resilience resulted in benefits of \$2.9 in Kenya in the form of reduced humanitarian spend, avoided losses and development gains. It will also improve the ability of the Government to provide integrated assistance to poor people in the arid lands through a common registry of all households in the poorest counties and establish the conditions to allow a more diverse business environment. The ASP will include a resilience fund to provide additional resources, so that in bad seasons (when environmental triggers are breached) the number of HSNP beneficiaries and size of payments can be increased, whether supported by DFID or other donors.

A new £16.8 million three-year **nutrition programme** will treat more than 65,000 malnourished children and 10,000 women every year in the area. The programme will not only help them to recover, but also prevent acute malnutrition through improved access to micronutrients, as well as counselling on mother, infant and young child nutrition and care practices. The programme will also strengthen the resilience of the Government-led health system to prepare and respond to spikes in need. This will be through support to human resources, coordination, planning, monitoring, nutrition information systems and communication efforts. DFID and partners will also agree early warning indicators that, if breached, can lead to a programme budget revision (and if necessary consideration of additional funding) to support scaled up preparedness and response activities.

A new national-level **Education programme** (£25.2 million) has a strong focus on building schools and subsidising the costs of education in the arid lands. It will enable 200,000 more children to attend schools in the area by 2015.

An extended **Market Access for the Poor (MAP)** programme will help to strengthen market linkages and build the commercial enterprise base in the arid and semi-arid lands in a range of markets. A detailed scoping study is already underway on commercialised livestock markets that have an impact on pastoralists and is examining other market options. Around 60% of planned programme activity will take place in arid and semi-arid lands areas and the programme as a whole will reach over 540,000 beneficiaries.

Next steps

- Greater and better-coordinated investment from the Kenyan Government and donors in the medium and long-term in the arid and semi-arid lands.
- Integration of predictable, flexible and cost-effective early response activities into development interventions.



BUILDING RESILIENCE IN NEPAL:

A multi-hazard approach

Summary: Nepal ranks high on the list of nations at risk from earthquakes, yet its state of preparedness for a disaster is poor. At some point in the future, Kathmandu will face a major catastrophe. International efforts to prepare Nepal for such an event are focused around the Nepal Risk Reduction Consortium.

Context

Nepal is highly prone to natural hazards - floods, landslides and earthquakes. A combination of climate change, rapid urbanisation and mountainous terrain makes Nepal highly vulnerable to such hazards. The occurrence of a major earthquake is the most deadly threat because of the likely massive loss of life and infrastructure.¹

The Kathmandu valley, the most densely populated area of Nepal, is at the highest risk in terms of human impact. A 'worst case' amongst likely scenarios is an earthquake with an epicentre approximately 200 miles west of Kathmandu. Recent estimates, based on a low population estimate, predict that a major earthquake (8+ Richter) is likely to result in 100,000 deaths, 300,000 people injured, over 1.5 million people homeless, and 60% of all buildings destroyed in the Kathmandu Valley alone.²

The Government of Nepal's priorities are being brought together within the Nepal Risk Reduction Consortium (NRRC). Led by the Government and coordinated by the UN, the NRRC aims to bridge the gap between humanitarian and development planning and programmes. The NRRC brings together the UN, Asian Development Bank and World Bank, Red Cross and development partners in an innovative institutional arrangement focussing on increasing disaster resilience in five priority 'flagship' areas³. The UK joined the NRRC in 2011, and has seconded a humanitarian expert to provide secretariat support to the Consortium and ensure engagement from multilaterals and donors.

¹ UK Support To Build Earthquake Resilience In Nepal—Outline Programme Document. DFID, NRRC Dec 2011

²Nepal High Level Symposium on Disaster Risk Reduction – Statistics and Scenarios

³The five Flagship areas are:

- Flagship 1: School and hospital safety (lead agency ADB/WHO);
- Flagship 2: Emergency preparedness and response capacity (UNOCHA);
- Flagship 3: Flood management in the Koshi river basin (World Bank);
- Flagship 4: Integrated community based disaster risk reduction/management (IFRC);
- Flagship 5: Policy/Institutional support for DRM (UNDP)

Country-specific challenges

Nepal ranks 157th out of 187 countries in the Human Development Index. High population density, on-going urban growth, poor construction standards and non-enforcement of building codes make urban populations in Nepal extremely vulnerable to disasters. It is widely acknowledged that disasters have the highest effect on poor people.

Inadequate community awareness and preparedness and limited community-based disaster resilience in Nepal has led to destruction and loss of life due to floods, landslides and earthquakes, which could have been mitigated. Public awareness of what to do in a disaster is low, as is the perception of risk within the population.

On-going political instability and the lack of a legislative parliament, following the dissolution of the Constituent Assembly in May 2012, mean that Nepal's National Strategy for Disaster Risk Management remains in draft. Plans for strengthened disaster management and creation of a National Disaster Management Agency are therefore on hold.

The high level of vulnerability to a large earthquake in Nepal is further compounded by the likelihood that international response mechanisms would be compromised. Various planning scenarios point to the likely damage that an earthquake could have on the airport and access roads to the Kathmandu Valley. Weak national systems, such as the military, police and health services, may be forced to deal with the consequences of a disaster unaided for a significant period of time and, significantly, beyond the typical time span of search and rescue efforts.

UK response

The UK's climate and disaster resilience programmes in Nepal are focused on strengthening the institutional architecture for Disaster Risk Reduction (DRR) and supporting a multi-hazard approach to risk reduction in vulnerable communities. The programmes aim to increase preparedness and improve the capacity of Nepal's disaster management systems, building the resilience of four million people to earthquakes and other shocks. The four outputs, in line with NRRC flagship programmes are:

- Building national resilience through policy/institutional support for national disaster risk management and response planning, training 600 Government workers;
- Building local resilience through community-based earthquake and disaster preparedness in 200 village development committees, rebuilding 162 schools in earthquake-affected areas (see box);
- Protecting health services, including seismic assessment of 50 hospitals in Nepal and the development of retrofitting plans in 10 major hospitals.
- Improved preparedness for emergency response, training 4,000 volunteers in search and rescue/first aid.



An earthquake measuring 6.9 on the Richter Scale affected the eastern region of Nepal, as well as the capital of Kathmandu, on 18 September 2011. A total of 18 districts were affected by the earthquake. Up to 60% of schools and health posts in some districts were severely damaged.

Working with **UNDP** and **Save The Children**, **DFID** has provided early recovery support to rebuild priority schools in Eastern Nepal. Save The Children is providing engineering and retrofitting training to local and district government and undertaking community-based disaster risk reduction activities to enable communities to increase resilience.

(Image: Re-building a school in Ilam, Nepal)

Photo credit: Phillip Smith - DFID

The UK's intervention adapts community-based and largely rural approaches to resilience to an urban environment, supporting hard-to-reach groups in cities to increase their preparedness for a major earthquake. It will engage the private sector in improving disaster risk management in Nepal, including the construction industry, ICT/telecommunications industry and the banking/insurance industry. It will also include a direct bilateral arrangement between DFID Nepal and the International Committee for the Red Cross.

Next steps

1. National legislation on land use planning and building codes must be strengthened and enforcement improved. The UK is supporting UNDP's work on this.
2. Resilience can be built by increasing awareness and provision of information to communities and individuals about how to prepare for disasters, what to do during an earthquake and how to reduce risk. The UK is working with the Red Cross and other international NGOs to increase preparedness.
3. The capacity and number of first responders trained in first aid and search and rescue needs to be increased and linked to national systems for disaster response. This will increase the number of survivors rescued from collapsed buildings following an earthquake. The UK is supporting efforts to develop a formal urban search and rescue capacity in Nepal.
4. The UN-instigated NRRC should be praised as an innovative effort to focus Government and donors on shared disaster resilience priorities. The model could be replicated in other contexts.
5. The Government of Nepal should prioritise disaster risk management and commit senior level time and resources to it.

Annex: The Strategic Case for the Building Resilience and Adapting to Climatic Extremes (BRACED) programme.

Introduction

1. Under the International Climate Fund (ICF), DFID will design a two phase programme “Building Resilience and Adapting to Climatic Extremes programme” (BRACED). This strategic case sets out the justification for the first four year £140 million phase, answering the following of questions:

The Problem:

- What has been the impact of climate extremes?
- What are the impacts on nutrition?
- How do climate related disasters affect women?
- What are the implications of a changing climate for future disasters?
- What are the regions and countries most at risk?
- What are the main policy and institutional challenges?
- Where should BRACED work?

The Response:

- How do we build resilience to climate extremes?
- How does combining Disaster Risk Reduction and adaptation help build resilience?
- What policy and institutional links are needed to sustain and build resilience?
- What are the best practices and approaches to build resilience?
- Why is UK Government intervention needed?
- What are the consequences of not intervening?

The Policy and Programme links:

- How does the programme link to ICF priorities?
- How does this programme link to DFID’s overall response to the HERR and action on DRR?
- How does BRACED contribute to HMG strategy on the Sahel?
- What are the links to Future Fit?
- What are the links to DFID global, regional and country humanitarian and DRR initiatives?
- What are others doing?

A. Context and the Problem

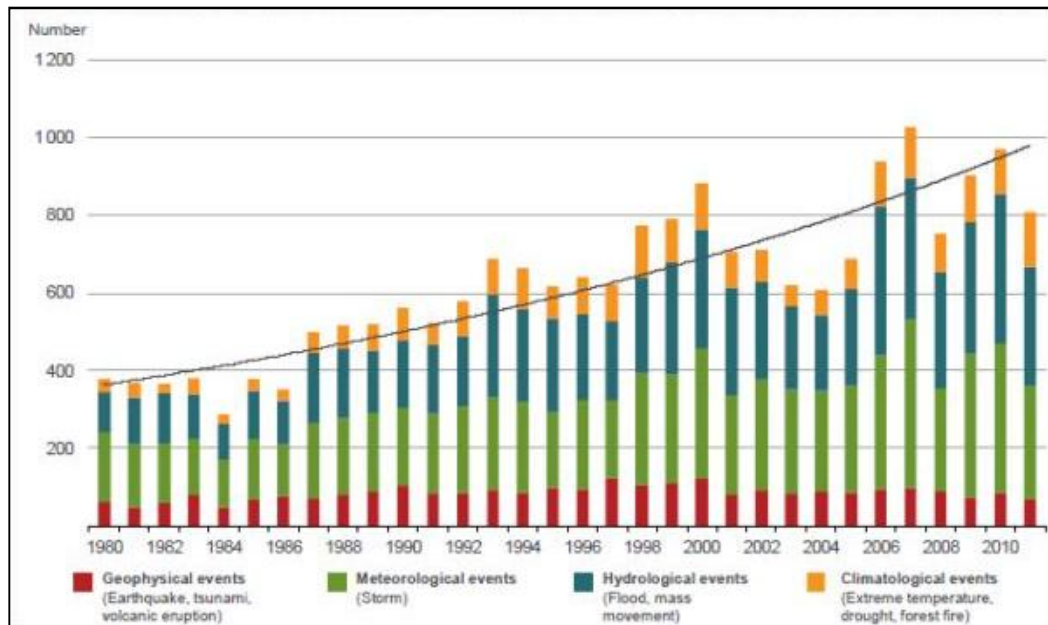
What has been the impact of climate extremes?

2. The consequences of climate change can be summarised as higher temperatures, changing rainfall patterns and rising sea levels which in turn result in climate extremes such as droughts, floods, cyclones and landslides. The 2012 IPCC “Special Report on Managing the Risks of Extreme Events (SREX) and Disasters to Advance Climate Change Adaptation” provided clear evidence that climate change has already affected the magnitude and frequency of some climate extremes including sudden onset such as floods and landslides and gradual onset such as droughts and saline intrusion from sea level rise¹. Figure 1 shows the increase in extreme events² over the last thirty years.

3. As populations increase more people live and practise their livelihoods in locations vulnerable to extreme climate events. Where such events converge with vulnerability of human systems, disasters can occur. There have been 3.3 million deaths from natural hazards in the 40 years to 2010 (82,500 per annum) with 95% in developing countries. Droughts are the deadliest with almost 1 million people

dying in Africa's droughts alone³. Since 2000 there have been over 400,000 deaths from climate extremes (droughts, floods, extreme temperature, landslides, storms and wildfires) with 79% of those occurring in developing countries⁴ (see Table 1).

Figure 1 Global extreme events 1980 to 2011⁵



4. There is strong evidence of increasing risks to national economies and to the livelihoods of poor people from current climate and weather conditions – both from sudden events and from gradual change. Fatality rates and economic losses as a percentage of GDP are the highest in developing countries⁶; whilst total economic disaster losses are higher in developed countries.

5. The IPCC SREX report provides evidence that economic losses from climate-related disasters is increasing⁷, with a large year on year variation. Estimates of economic impact in developing countries often only take account of tangible impacts and ignore the large impact on livelihoods at the household level; an impact which is difficult to measure and aggregate. In fact it is the poorest that are most vulnerable to disasters. Many of the poorest will not recover from the forced selling or loss of their assets. They may become destitute and their children malnourished, often dropping out of school. Disasters destroy livelihoods and aspirations, as well as lives. Box 1 provides examples of these more indirect impacts.

Table 1: No of people seriously affected by climate related disasters since 2000⁸

| Type of climate extreme | No. of people affected (millions) | | |
|--|-----------------------------------|--------------------|------------------------------|
| | All countries | non-OECD countries | Percentage non-OECD of total |
| Drought | 906.26 | 903.7 | 99.7% |
| Extreme temperature | 89.85 | 89.61 | 99.7% |
| Flood | 1275.92 | 1257.93 | 98.6% |
| Mass movement (landslides) after rains | 3.94 | 3.94 | 99.9% |
| Storm | 444.5 | 427.9 | 96.3% |
| Wildfire | 2.19 | 1.17 | 53.5% |
| Total | 2,722.66 | 2,684.25 | 98.6% |

6. The Human Development Report from 2007/8 and the 2012 Foresight report on Reducing Risks of Future Disasters both emphasise the long term and indirect impacts of disasters. This is because the strategies used to manage increased risks can often reinforce deprivation. The poor may be forced to sell productive assets to protect consumption, with implications for longer term recovery. When asset sales, are not enough households resort to cutting meals, taking children out of school and reducing spending on health. If households do not have access to safe assets then an increase in risk may lead to lower levels of saving, in this way adverse shocks can have long-lasting negative effects⁹. In addition the 2011 Foresight Report on Migration and Global Environmental Change¹⁰ found that when the impacts of disasters are irreversible and land becomes unviable, migration becomes the most viable coping strategy. In these circumstances the poorest communities are at risk of becoming 'trapped populations' unable to obtain a livelihood where they are but too poor to afford to move.

7. Many developing countries are geographically more vulnerable to the impacts of climate extremes than high income countries. They are also the least able to cope with the impacts on their economies, governance, infrastructure and services.

Box 1: Examples of indirect impacts of climate related disasters

- **Loss of economic activity.** Overall GDP can fall by 0.6% after a drought of median intensity.¹¹ In a study of 85 disasters in 45 countries growth fell in the disaster year and did not increase to compensate in subsequent years.¹²
- **Nutritional impacts.** Ethiopia; children aged 5 or less are 50% more likely to be malnourished if they were born during a drought. This translated to 2 million additional malnourished children in 2005. Niger; children aged two or less born in a drought year were 72% more likely to be stunted.¹³
- **Educational outcomes.** Zimbabwe; children aged 12 to 24 months during the 1982-1984 drought who were stunted, had lower grades 13 to 16 years later and a 7% loss in extrapolated lifetime earnings¹⁴.
- **Conflict.** Drought has been associated with conflict in Niger. Conclusive evidence on causal links is difficult to obtain though Miguel et al (2004) estimate that in Africa a 1% increase in annual rainfall can reduce the probability of serious conflict by 6%¹⁵.
- **Trade.** One study found that developing countries experienced a decline of more than 20% in exports following a domestic disaster, with negative effects lasting for at least three years¹⁶. In 2008 a rapid increase in world rice prices fuelled by disasters and pest outbreaks in rice producing countries contributed to a world food crisis¹⁷.

What are the impacts on nutrition?

8. Evidence from regions affected by climate extremes demonstrates the impacts on nutrition and long term resilience. Gambian studies reveal that women who are pregnant during a hunger gap give birth to smaller babies¹⁸. Longitudinal studies in Malawi have shown a seasonal variation, linked to the annual hunger season, in height gain among young children¹⁹. In Ethiopia and Niger, children born during a drought are more likely to be chronically malnourished later in childhood than those who are not²⁰. The prevalence of chronic undernutrition has been found to increase among Bangladeshi children following flooding²¹. In fact, it has been estimated that more than 20% of adult height variation in developing countries (the physical sign of having experienced chronic undernutrition in childhood) is determined by environmental factors, in particular drought²².

9. Ensuring that development and adaptation investments support improvements in the nutritional status of communities will help to build their resilience²³. However, these investments might not go far enough to protect nutrition outcomes when shocks arise. It is already recognised that nutrition-sensitive

interventions crucial for ensuring optimal nutrition outcomes are not currently sufficiently disaster proofed to maintain effectiveness in the face of crisis²⁴.

10. A study of disaster resilience in the Sahel noted that “*there is no better single indicator of resilience...than the level of child malnutrition*”. The report went on to propose that “nutrition security” be placed at the apex of the pathways to resilience²⁵.

How do climate extremes affect women?

11. Women are more vulnerable to the effects of natural disasters than men. For example a study of 141 natural disasters over 1981–2002 found that when economic and social rights are equal for both sexes, disaster-related death rates do not differ significantly for men and women. But when women’s rights and socio- economic status are not equal more women than men die in disasters²⁶. In Bangladesh, for example, of the 140,000 people who died from the flood-related effects of Cyclone Gorky in 1991, women outnumbered men by 14:1. Factors limiting women’s mobility and use of cyclone shelters were social norms and roles for women including primary responsibility for the care of children, the sick and elderly; social norms preventing women from leaving their homes or staying in cyclone shelters without a male relative; traditional dress codes such as the wearing of sarees that can easily become entangled; and concerns around privacy and safety in shelters. Women also represented an estimated 61% of fatalities in Myanmar after Cyclone Nargis in 2008, and 70% of those dying during the 2004 Indian Ocean tsunami in Banda Aceh, Indonesia²⁷.

12. Empowerment of women is an important ingredient in building climate resilience. There are now a wide range of studies on how empowering women in communities contributes to climate resilience²⁸. There is also strong and mounting evidence at the country level that improving gender equality contributes to policy choices that lead to better environmental governance, whether through increased representation and voice of women within their communities, in society at large, and at the political level, or through increased labour force participation. In Nepal and India women’s participation in forest committees beyond a critical minimum threshold (around a third) has been seen to have a positive impact on forest regeneration and a reduction in illegal extraction of forest products²⁹.

13. There is evidence that where women are empowered this can serve as a powerful springboard for building climate resilience. Good examples of how this can be done are seen in programmes that seek to build climate resilience through gender sensitive approaches to supporting rural livelihoods. In pastoral communities in Kenya and Ethiopia building resilience to drought, with a particular emphasis on empowering women to be agents of change, helped communities better manage the risks associated with the 2005–08 drought cycle by generating income, preserving assets and enhancing food security.³⁰

What are the implications of climate change for future disasters?

14. The impacts of climate related disasters are already being experienced (for example Pakistan floods, droughts in the Sahel and Horn of Africa, and floods in Mozambique) and action is needed now to build the resilience of people. The risks of climate related disasters are likely to increase with climate change. The IPCC SREX report and the Foresight report on reducing the risks of future disasters both recognise the relative infrequency of particular types of extremes limits the data available to make assessments regarding changes in their frequency or intensity. The more infrequent the extreme event, the more difficult it is to accurately identify long-term changes. Evidence on these extremes varies depending on the event and region and the SREX report gives confidence or probability ratings for each³¹. The report does conclude that over the 21st century the world will get hotter on average, and

while there is uncertainty over by how much, and what this will mean for different places, we can expect³²:

- **Temperatures will rise.** Models project substantial warming in temperature extremes by the end of the 21st century.
- **Extremes in rainfall will increase.** It is likely that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase over the 21st century in many areas. In some regions increases in heavy precipitation are likely to occur despite projected decreases in total precipitation in those regions.
- **Sea level will rise.** It is very likely that mean sea level rise will lead to upward trends in extreme coastal high water levels.

Leading to an:

- **Increase in droughts.** Medium confidence that droughts will intensify in the 21st century in some seasons and areas due to reduced precipitation and/or increased evapo-transpiration;
- **Increase in floods.** Medium confidence that projected increases in heavy rainfall will contribute to increases in local flooding in some catchments or regions
- **Increased risk of storms.** Tropical cyclone and hurricane wind speeds are likely to increase, but low confidence in projections of changes in extreme winds. The very likely increased extreme coastal high water levels coupled with likely increase in tropical cyclone wind speed, is a particular issue for tropical small island states.
- **Increased risk of heat waves.** There are likely to be more incidences of periods of high temperature and heat waves³³. These will have direct impact on people's health and deaths, and damage to crops. Indirectly this could lead to the increased risk of wildfires and associated disasters and loss of lives and assets.

15. Future climatic change in the Sahel is uncertain, with some models projecting a prolonged dry period and others an increase in precipitation. Temperatures are likely to rise with damaging impacts on both pastoralism and agriculture. FAO has predicted a significant decline in global cereal production by 2050 with a 20-50% decrease in productivity in the Sahel³⁴.

16. In summary, the climate is changing and is likely to continue to change, although there is uncertainty about precisely how it will change. For the next 20 years or more the main impact of these changes is likely to be an increase in the number and intensity of climate extremes. The potentially devastating impacts of the gradual rise in global temperatures and sea levels are not likely to be felt fully until the middle of the 21st century and beyond. Vulnerability to climate change is, therefore, closely linked to climate-related disasters. It is important to note that climate is only one factor that will affect vulnerability – some studies³⁵ suggest that the patterns of socio-economic development also increase the vulnerability of poor people as much as the climate. Failure to correct 'mal-adaptive' patterns of socio-economic development will increase the risks and damage and loss from climate change.

What countries and regions are at most risk?

17. As well as suffering the overwhelming majority of deaths, developing countries are highly vulnerable to the impact of extreme climate events. Developing countries are more vulnerable because:

- They have less resilient economies and depend more on climate sensitive activities;
- They are often poorly prepared to deal with climate variability;
- They are at risk from mal-adaption due to lack of finance, information and techniques in risk management, plus poor governance;

- There has been little consideration of climate proof investment in areas of growing population; and,
- They are already at an adaptation deficit' from low levels of economic development.

The Sahel as an example of a region at risk

18. One region that has repeated climate related disasters is the Sahel. The root causes of vulnerability in the Sahel are the lack of resilience to shocks and stresses caused by drought, floods and conflict. Building resilience is vital to break the cycle of recurrent humanitarian crises in the region. The 2012 food and nutrition crisis and its aftereffects are still being felt by millions of people across the Sahel (Table 2). At the peak of its intensity, the crisis disproportionately hit the very poorest in society. Many reverted to adverse coping mechanisms including selling of livestock and buying food on credit.

19. In the Sahel both climate change and population growth will lead to increased competition for resources with the real risk that this could fuel further conflict in a region that is already deeply affected by conflict and insecurity. With a reliance on rain-fed agriculture, a lack of infrastructure and few diversification options, the region will be hit disproportionately hard by climate variability and is expected to be one of the worst affected regions globally by climate change. These stresses will be exacerbated by population growth. Annual population growth in Niger is over 3.5%, and the population of the Sahel will double by 2050.

Table 2: Numbers food insecure people in the Sahel 2013³⁶

| Country | Total Population (2010) | No of people at risk of food insecurity | % of total no at risk across the Sahel |
|---------------------|-------------------------|---|--|
| Burkina Faso | 16,469,000 | 1,700,000 | 10 |
| Chad | 11,227,000 | 1,800,000 | 16 |
| Mali | 15,370,000 | 2,000,000 | 13 |
| Mauritania | 3,460,000 | 1,000,000 | 29 |
| Niger | 15,512,000 | 2,500,000 | 16 |
| Total | 62,038,000 | 9,000,000 | |

20. Severe and persistent poverty means that people in the Sahel are extremely vulnerable to shocks and stresses. Sahelian countries are collectively among the poorest and least developed countries in the world. According to UNDP's Human Development Index for 2011 Niger was ranked 186 out of 187 countries; Chad 183, Burkina Faso 181 and Mali 175. Indicators such as infant mortality, maternal mortality, nutritional levels and health coverage are amongst the worst in the world. Gender inequalities are also some of the highest in the world; in the 2011 Gender Inequality Index Chad ranked 145 out of 146, Niger 144 and Mali 143. Women are key actors in agricultural production, marketing food commodities, family food preparation and consumption, dietary habits, family and community health, and educating children. Yet, they often face persistent obstacles and economic and social constraints limiting their inclusion in decision-making in the field of agriculture and business.

21. There is a very high prevalence of malnutrition in the Sahel. An estimated 645,000 children die in the Sahel every year, with an estimated 226,000 of these deaths being directly linked to malnutrition. Sahelian countries suffer from low levels of education, lack of access to basic services, poor governance and weak markets. High food prices and price volatility have been a major contributing factor to recent food crises in the Sahel, meaning that poor people are unable to purchase food even when it is available, affecting both rural and urban households.

22. Conflict, civil war, military coups d'état, corruption, weak governance and poor human rights records have characterised the region for decades. Niger and Chad have experienced major conflicts in recent years and there is on-going conflict in Mali, resulting in over 430,000 displaced people³⁷. There is a need for significant, long-term efforts by donors to strengthen governance and political leadership, particularly in fragile states, such as Chad, which currently cannot effectively manage major increases in aid.

23. A further example of the impacts of a climate related disaster are the floods in Pakistan where up to 3000 people were killed, over a million homes destroyed and more than 21 million people were seriously affected. In the immediate aftermath of the 2010 floods US\$2 billion was needed for emergency relief, recovery needs came to a further US\$2 billion. After the disaster a longer term damage needs assessment was undertaken, led by the World Bank and the Asian Development Bank³⁸. This estimated US\$8.7 to 10.9 billion was needed to reconstruct and rehabilitate the infrastructure, institutions and services that had been destroyed or damaged by the floods. This also stated the impact of the floods on the overall growth trajectory of Pakistan. At a household level the impacts are also significant; an impact assessment of 1800 households six months after the floods found that 85% of the households had reported incomes losses of up to 50%.³⁹

24. DFID has identified the countries that are at risk from disasters as priorities to support in developing their overall resilience⁴⁰. Many of these disasters are climate related and BRACED will provide grants to NGOs to support interventions in these countries.

What are the main policy and institutional challenges?

25. The early years of the 21st century have seen an increase in the commitment of the international community to reducing disaster losses. The International Strategy for Disaster Reduction (UNISDR) is a strategic framework adopted by the United Nations Member States in 2000, to guide and coordinate the efforts of a wide range of partners to achieve a substantive reduction in disaster losses.

26. In 2005, the international community approved the Hyogo Framework for Action; a 10-year plan to make the world safer from natural hazards. In response to the Hyogo Framework, in 2006 the Global Facility for Disaster Risk Reduction and Recovery (GFDRR) was established with a Secretariat in the World Bank. The mandate of the GFDRR is to mainstream disaster risk reduction and climate change adaptation into country development strategies, especially those focussed on poverty reduction, and into the operational strategies of the World Bank in order to support them. It works in partnership with UNISDR, whose mandate is to co-ordinate the UN system on disaster risk reduction.

27. Disaster risk reduction and climate resilience now have a higher profile and this is leading to increased support from multilateral and bilateral donors. In providing this it is important to recognise and address the institutional challenges. Building climate resilience can involve global, regional, national, and community financiers and stakeholders but the outcomes of specific interventions are geographically, community or sector specific. International priorities can (from a national perspective) be seen by some Governments as an opportunity to gain funding for unfunded projects across a range of national priorities. However, building climate resilience requires that the priorities of the people most vulnerable to climate change - the poor and politically excluded - are fully understood and taken into account. An understanding of the institutional complexity and the participation of local councils, civil society, the private sector and communities will be crucial to the success of any interventions.

28. The political will to fully address climate adaptation and climate resilience in many countries is often weak. This lack of political will carries several risks. Climate resilience may be seen mainly as a source

of donor finance and the lead is given to a “political” Department which may become a “gatekeeper” and make funding decisions based on “political” rather than developmental priorities. In the absence of a technically competent lead Department, it becomes more difficult to develop capacity and build a better understanding of climate resilience. Mainstreaming climate resilience nationally requires action by a range of institutions and actors, from central to local government and the private sector to civil society. Without the political will and an associated commitment to putting in place and supporting effective institutional arrangements, this will not happen.

29. There can be a lack of a common understanding of the term “climate resilience” by Governments and development practitioners. Successful investment in climate resilience will require a common understanding of what climate resilience is and how it can be achieved. There is a case for a significant investment in improving understanding of climate resilience across the development community and, particularly, in developing country Governments.

Where should BRACED work?

30. In conclusion, in determining where BRACED should work we considered the evidence presented on which regions and countries were most at risk from climate extremes, and countries which did not yet have the capacity to respond and/or where support from development agencies on DRR and adaptation is most lacking. The following were identified for BRACED:

- The Sahel – Burkina Faso, Chad, Mali, Mauritania, Niger and Senegal.
- DFID focal countries at risk from climate extremes⁴¹ (Pakistan, Burma, Ethiopia, South Sudan, Uganda, Kenya, Nepal and Mozambique).

31. BRACED will work at three levels of policy and governance: local, national and regional. In particular it will focus its efforts on linking local and national policies. Part of this will be linking up community and NGO action in DRR and climate adaptation, and to learn the lessons on how to scale up actions and the policies and institutions needed for this. Successful programmes that have scaling up interventions for resilience have included actions that institutionalised these interventions into local to national governance systems. BRACED will work to increase investments in time and money into local to national capacity and institutions to take outputs to outcomes.

B. The Response

How do we build resilience to climate extremes?

32. The response to the challenges outlined above should be to improve the resilience of people and communities to climate extremes. Resilience can be defined as “the long-term capacity of a system or process to deal with change and continue to develop”. Building climate resilience (Box 2) requires strengthening the ability of households, communities and countries to anticipate, absorb, accommodate and/or recover from climate extremes. This means where possible preventing a climate event becoming a disaster by avoiding or mitigating the impacts, and enabling countries and communities to quickly recover.

33. The response to the risks posed by climate extremes may take the form of moving people out of harm’s way (early warning systems and evacuation plans), shelter/physical protection (sea walls community infrastructure, environmental protection, building regulations), ensuring that essential services, food and water remain available during and after a crisis so that the poor don’t have to sell

their assets (social protection, insurance, food stocks), promoting resilient livelihoods (livelihood diversification, drought resistant crops), ensuring that information knowledge is available to plan for these actions (climate and weather forecasting and the capacity to assess the risks systematically) and helping communities to recover as quickly and effectively as possible. As BRACED is responding to both slow onset disasters (mainly droughts in areas suffering from chronic food insecurity) and rapid onset disasters (e.g. cyclones and floods) it will need to support a wide range of interventions.

How does combining Disaster Risk Reduction and adaptation help build resilience?

34. Disaster Risk Reduction (DRR) is an approach that evolved from humanitarian relief, to go beyond emergency responses to a planned approach to reduce the risk of disasters occurring and the impact when they do occur. DRR provides a framework to build resilience to climate extremes, through measures including; identifying the risk, transferring the risk (for example re-insurance), avoiding the risk (for example early warnings), and reducing the risk (for example preparedness of infrastructure).⁴² Disaster risk reduction shares some key characteristics with approaches to building resilience: (1) it is a holistic framework for assessing national systems, communities and individuals; (2) it places an emphasis on capacities to manage hazards or risks; (3) it incorporates options for dealing with uncertainty, surprises and changes; and, (4) it is proactive⁴³. A system that is effective in managing risk is likely to become more resilient to shocks and stresses.

35. A study⁴⁴ on the economics of resilience in Ethiopia and Kenya clearly demonstrated the need to combine DRR and development together. In Kenya the study found that early response to drought could save between \$107m and \$167m for a population of 367,000 in a single event alone. In southern Ethiopia, with a population of 2.8m, household level data suggest that early response could save between \$662m and \$1.3billion in a single event.

36. However as identified by the HERR, the DRR approach does not sufficiently address the risks that climate change poses; so there is a need to integrate climate change risks into DRR. Climate extremes differ from the traditional hazards that DRR addresses in some important aspects. Unlike other hazards⁴⁵ we know the risks posed by climate extremes are going to increase over the longer term, on the other hand there is considerable uncertainty as to exactly how these changes will manifest and managing climate risks requires being prepared for surprises – for example the one in a hundred year flood happening every ten years. Therefore a flexible approach that can incorporate new information as it is generated is important as well as investment in improved forecasting and knowledge of what works, to reduce uncertainty and enable choice and capacity to respond. There is a need for coherence with climate change adaptation interventions, such as resilient agricultural development, that seek to keep development on track in the face of climate change, and for a joined up approach and understanding between communities of practice on DRR and climate change resilience. In summary we need to make DRR 'climate smart'.

What policy and institutional links are needed to sustain and build resilience?

37. There is also a need for better connections between local and national approaches. For example investment in national early warning systems will have limited impact on the lives of millions of poor people without local investment in, for example, cyclone shelters so that people can act effectively on the warnings. At the national level and in the context of policy formulation, it is necessary to consider the vulnerability to climate extremes from a sector perspective. For example the water, tourism, health, urban, agriculture, and housing and transport infrastructure sectors are all clear priorities. On the other hand, at the community and household level, planning purely from a sector perspective is less helpful. Poor people have complex livelihoods and it is more appropriate to identify the specific risks

communities may face (such as drought, floods, saline intrusion) and build resilience from the perspective of their livelihoods. For example recent local climate resilience assessments in the drylands of Kenya have shown that it is better, from poor people's perspective, to focus on measures to make local economies and natural resource governance systems resilient.⁴⁶ Interventions should be based on the priorities of communities and an understanding of what works, and this engagement should be maintained through the implementation.

38. The most effective disaster risk reduction and climate adaptation actions are those that deliver development benefits in the short-term and reduce vulnerability in the long-term⁴⁷. They combine efforts to tackle the causes of poverty and vulnerability, integrate knowledge of changing risks and build adaptive capacity. The BRACED programme will seek to build coherence across this spectrum, from immediate humanitarian response, to traditional DRR, to longer term adaptation to climate change and resilient growth. BRACED will address the HERR recommendation to integrate the threat from climate change into disaster risk reduction by expanding this approach to explicitly accept the high levels of uncertainty around climate events and respond accordingly, it will work across the DRR, social protection and climate adaptation disciplines, and across 'top-down' institutional and 'bottom-up' community approaches, whilst building evidence on what works and why. Only by embedding efforts to build climate resilience within permanent institutional processes will it be possible to achieve the strategic, coordinated and long-term perspective that an effective response to climate change requires. Box 2 provides a case study of a successful intervention to help build the resilience of farmers in the Sahel, which built on grassroots actions and linked with wide range of different institutions.

Box 2: Example of success - Regreening the Sahel

Recent studies⁴⁸ on long-term trends in agriculture and environment in the Sahel show some interesting trends. The first is that farmers in several densely populated regions of Niger protect and manage the natural regeneration of trees and bushes on their farms. This process was catalysed from around 1985 and has since led to much higher on-farm tree densities on a total of about 5 million hectares. This is the largest-scale recent environmental transformation in the Sahel - and possibly in the whole of Africa.

This protection and management of useful trees on farms concerns a number of indigenous species such as *Faidherbia albida* (a fertiliser tree that also produces large quantities of fodder for livestock), *Piliostigma reticulatum* (fodder, soil organic matter, fuelwood and poles), *Combretum glutinosum* (fuelwood and poles), *Adansonia digitata* (leaves and fruit for high-quality nutrition), *Guiera senegalensis* (fodder, green manure and fuelwood), and Shea trees (which provide about 40% of the income of rural women in Mali).

The resulting tree cover is estimated to produce about 500,000 additional tons of grain each year, enough to feed about 2.5 million people⁴⁹. The annual production of these new trees is now worth at least 200 million euro to the farmers. This estimate the values of produce and own use of non-food tree products. These agroforest parklands appear to be spreading in the Sahel: recent work by the US Geological Survey has mapped an expansion of parklands on about 450,000 hectares in the Seno Plains of Mali (Tappan, 2012).

A paper⁵⁰ about to be published looks at farmer's perceptions of the impacts of re-greening on food security in Niger shows that the Kantché district (350,000 inhabitants) in Southern Zinder, which is characterized by high population densities and high on-farm tree densities, produced a grain surplus in 2011, a year of below-average rainfall, as well as in the four preceding years. Besides this, some species, like baobab, produce significant cash income through the sale of the leaves. During drought years, many farmers in the Sahel literally survive thanks to their trees: these provide non-food products (timber etc.) whose sale in the market allows the purchase of sufficient food and of seed for the next planting season.

Why is government intervention needed to help build resilience to climate extremes?

39. Some people will adapt to an increase in climate extremes by changing their behaviour, their

livelihood strategies and changing their geographical location. However not everyone, especially the poorest, will have the means to make the changes needed. There is a strong case for government intervention to help these people to adapt to climate extremes.^{51,52}

40. Governments can also seek to influence the broad patterns of macroeconomic development that can build resilience to climate extremes and disasters. We know for example, that macroeconomic stability can help countries recover from extreme events⁵³. We have less evidence on what types of policy work help build resilience across communities within a country.

41. Whilst these factors provide a rationale for Government investment in building resilience to all natural hazards, they particularly apply to climate extremes where the risks are increasing, uncertainty is high and the past does not provide a guide to the future, making ‘autonomous adaptation’ by the poorest and most vulnerable families and communities even harder, in the absence of Government support.

Table 3: Why governments should be involved in building resilience to climate extremes⁵⁴

| Rationale | Description and examples |
|---------------------------------|--|
| Public goods | <p>Public goods are goods that the market does not provide on its own because people can “free ride”, or use the good without paying. These goods will only be provided by government – for example flood protection is provided by government because a private company would find it difficult to charge people for this service.</p> <p>Many goods needed to help build resilience to climate extremes are public goods; including flood protection, better sea defences, and dissemination of climate information.</p> <p>Often it is not profitable for insurance companies to provide insurance against climate extremes⁵⁵, which means that governments have a role as the insurer of last resort.</p> |
| Assistance to vulnerable groups | <p>Governments have an important role in protecting poor and vulnerable people in society. Many people in developing countries are too poor to bear the costs of adaptation on their own, and especially for a problem they have not caused</p> <p>For example, poor people in flood prone areas may be unable to afford the costs of raising their houses on plinths.</p> |
| Governance failures | <p>The SREX report notes that the ability of governments to implement disaster risk management responsibilities differs significantly across countries, depending on their capacity and resource constraints. Governments (and other spending organisations) sometimes fail to provide disaster risk reduction and other adaptation goods and services because they:</p> <ul style="list-style-type: none"> (i) Lack institutional capacity; (ii) Are uncertain about when disasters will occur; (iii) Have limited knowledge and experience of the costs of disasters and the benefits of early action. |

What are the consequences of not intervening?

42. As the HERR highlighted it is predicted 375 million people a year will be affected by climate related disasters by 2015 and the number is expected to increase over time. This programme will make 5 million people more climate resilient by 2015, by large-scale funding at the grassroots level. The evidence building and institutional capacity strengthening components in the long term can be expected to benefit many millions as new programme innovations are introduced, and improved institutional and

policy frameworks lead to more effective government action.

43. In addition the programme is expected to serve as a catalyst for Governments, the private sector and NGOs to provide additional funding, both directly to build climate resilience but also for long-term investments to reduce poverty. By “doing nothing”, 5 million people would not receive direct support and become climate resilient. Instead they are likely to become increasingly vulnerable as extreme climate events become more frequent and intense. Without the evidence building component the opportunity for learning lessons and strengthening institutions and improving policies will be lost. This will mean many more people remaining vulnerable to climate extreme events and disasters. Not supporting the Sahel Resilience Strategy could lead to increased humanitarian disasters in the Sahel and increased instability in the region.

C. Policies, Strategies and Programmes

How does this programme link to International Climate Fund (ICF) priorities?

44. Disaster Risk Reduction was identified as a priority for investment in the International Climate Fund (ICF) Implementation Plan (2011 – 15), approved by Ministers. This states: ‘*The ICF will prioritise investment for adaptation in the following sectors through multilateral and bilateral channels - Disaster risk reduction (DRR) investments such as integrated DRR and adaptation planning, critical infrastructure, developing early warning systems, macro and micro insurance and addressing impacts on girls and women*’. In addition DRR is a key aspect of other priority adaptation sectors under the ICF including agriculture, infrastructure and urban investments, coastal zone and ecosystems management and social protection.

How does this programme link to DFID’s overall response to the HERR and action on DRR?

45. The BRACED programme offers an important opportunity to help meet commitments under the UK Government response to the Humanitarian Emergency Response Review (HERR)⁵⁶. The HERR recommends that the UK Government should do more to help people become better prepared to cope with the impact of future emergencies- to ensure that they remain hazards and do not turn into disasters. According to the report, doing this requires a renewed focus on resilience and preparedness. Of most relevance is the HERR recommendation that ‘DFID should ensure that building resilience becomes part of its core programme in at risk countries, *by integrating the threat from climate change and other potential hazards into disaster risk reduction*’. The BRACED programme will be an essential mechanism for helping achieving this.

How does BRACED contribute to HMG strategy on the Sahel?

46. An important HERR commitment that BRACED will help to achieve is to ‘*champion the development of regional resilience programmes – starting with the Sahel*’. BRACED will support the Sahel Resilience Strategy led by Africa Regional Department (ARD). BRACED will address the priorities it identifies for example by providing resources to civil society organisations in the Sahel to build resilience at a community level and to hold governments to account at the national level.

47. BRACED is linked to the programme ***Building resilience in the Sahel through adaptive social protection***. This will provide up to £50 million over three years to support national systems for adaptive social protection in the Sahel. This programme will provide an additional tool to address the root causes of vulnerability in the Sahel for the poorest and build long term resilience to climate extremes such as

drought and floods, vital to breaking the cycle of recurrent humanitarian crises and conflict in the region, that trap millions in poverty.

48. ARD will work to ensure coherence between BRACED and ARD's existing portfolio in West Africa. This includes work on livelihoods, food markets, regional integration, climate change and innovative new risk financing mechanisms such as the Africa Risk Capacity initiative and the West Africa food markets programme.

49. BRACED will build on DFID's existing humanitarian programme in the Sahel. DFID is supporting humanitarian programmes in the Sahel in 2013, through UN agencies and NGOs, on immediate response and early recovery. Whilst humanitarian programming gives people the emergency support they need to survive and to start to recover from the current crisis, resilience programming will enable them to maintain or transform their living standards so that they are able to withstand shocks and stresses without compromising their long term prospects. Humanitarian programming is an essential counterpart to resilience programming, and will help ensure that resilience gains are not lost during crises that may occur in the coming years, but on its own is not sufficient to lift people out of extreme poverty.

What are the links to Future Fit?

50. Future Fit is a DFID Executive Management Committee (EMC) initiative to produce a vision and strategy for DFID's response to the challenges and opportunities that climate change and resource scarcity pose for poverty reduction and development. Future Fit asks the question what strategic shifts in our investment portfolio in front line sectors – Food, Water, Energy, and Cities are needed to protect development gains and respond to the challenge of climate change and resource scarcity. BRACED is responding to these challenges, and demonstrates the links between climate and development finance to deliver poverty reduction, growth and sustainable development goals.

What are the links to DFID global, regional and country humanitarian and DRR initiatives?

51. DFID's Conflict Humanitarian and Security department (CHASE) has agreed a grant of £20 million to the Global Facility for Disaster Reduction and Recovery (GFDRR) for track 2 (Mainstreaming disaster reduction in development). This is core funding for the GFDRR's overall operations to mainstream DRR and adaptation into national development strategies to achieve the MDGs. This type of funding is not tied to a particular theme or project and can be spent against any activity that relates to GFDRR's mandate; it will also help embed organisational-wide reforms, such as better reporting of results at the country level. Additional support to GFDRR will be an option appraised in the full business case for the fourth component of the programme.

52. BRACED will complement and support CHASE's work on Embedding Disaster Resilience in DFID Country Programmes. DFID's Structural Reform Plan states a commitment to do this by 2015, and was a direct response to the HERR. Eight country offices, Bangladesh; Ethiopia; Kenya; Malawi; Mozambique; Nepal; Sudan; and Uganda, have now done this and a further six, Burma, DRC, OPT, Pakistan, Somalia, South Sudan and Yemen, are in the process of doing so. One key lesson from the first eight countries was the need to **better link disaster resilience and climate change adaptation**. Many country offices combined the Climate Change Strategic Programme Review and Disaster Resilience work processes.

53. BRACED will support DFID county office resilience strategies in two ways. Firstly, funding NGO led

activities on DRR and adaptation, and policy and institutional work through component D. Secondly, through the Component C on building and sharing evidence on DRR and adaption the programme will benefit DFID's country offices and other development partners. BRACED will be an important source of knowledge, and for example in a country like Pakistan which is developing a major bilateral resilience programme, work to share the knowledge this generates.

54. CHASE is developing a new Global Humanitarian Action Programme (G-HAP) to provide up to £40 million to UK international NGOs to increase their capacity for humanitarian response to disasters. G-HAP and BRACED will complement as each responds to different and distinct needs and commitments in the Government's response to the HERR.

55. The Secretary of State co-chairs a 'Political Champions for Disaster Resilience' group with Helen Clark (UNDP). This group which consists of developing country and international development ministers, and development agency heads⁵⁷ has been convened to provide a greater focus and investment in disaster resilience. The champions met for the first time in April 2012 and agreed to focus initially on the key areas of regional resilience in the Horn of Africa and long-term resilience in the Sahel (as well as financial management of disaster risk and public-private innovation). The BRACED programme will be of clear relevance to the UK's commitments as part of this group to scale up investment in disaster resilience, and particularly resilience in the Sahel, and offers an opportunity for increasing donor and multilateral coherence, and engaging the private sector in this area.

56. DFID's Growth and Resilience Department (GRD) is working to promote the resilience of poor and vulnerable people so that growth strategies do not leave them behind. This will mean increased investment by Governments and other actors in longer term resilience-building such as social protection, livelihoods promotion, risk financing and insurance mechanisms and encouraging private investment strategies that are sustainable in the long term. Following recommendations of the DFID Development Policy Committee, GRD's resilience policy work focuses on food and nutrition security, climate change, and social protection. GRD works closely with CHASE taking the post-HERR disaster resilience agenda forward and we will work with them on the relevant outputs of BRACED.

What are the links to DFID's research programmes?

57. BRACED will complement other ICF investments in adaptation for small holder farmers and in urban areas. Two programmes are particularly relevant. The first is the Collaborative Adaptation Research Initiative for Africa and Asia (CARIAS) a research partnership with the International Development Research Centre (IDRC) with an investment of £37 million by the Climate and Environment Team in Research and Evidence Division. The second is the Climate Change, Agriculture and Food Security programme of the CGIAR (Consultative Group on International Agriculture Research) which includes research on the Sahel and in other regions at risk of climate extremes. BRACED will be expected to develop links with these programmes both in terms of using research evidence and in terms of informing the research agenda.

58. There is however little evidence on resilience in fragile and conflict affected states. DFID is therefore developing a new approach to build the knowledge and evidence base on resilience in such areas – which will include many BRACED focus countries. This will be jointly led by ARD, RED and CHASE. BRACED will ensure that the research/learning component is consistent with and supports this approach and that the programme is a major contributor to DFID's evidence base on resilience.

What are other development agencies doing?

59. A survey of international financing mechanisms and funding streams on disaster resilience⁵⁸ highlights other relevant organisations and initiatives working in this area. These include the UNDP Bureau of Crisis Prevention and Recovery (BCPR), which has a goal to 'integrate climate risk management and disaster risk reduction into broader national development and recovery plans', and the International Strategy for Disaster Reduction (ISDR) which is not operational but was setup to coordinate UN DRR activities at the global level. ISDR's first strategic level objective is that 'disaster risk reduction is accepted and applied for climate change adaptation'. This survey lists other significant donors on Disaster Risk Reduction to be Australia, Brazil, Canada, Denmark, European Union (through the European Commission Humanitarian Aid and Civil Protection Office – ECHO), Germany, Japan, Norway, Sweden, Switzerland and the United States, but does not identify climate change as a priority for any. This report found that despite the actions of these organisations and other recent initiatives, a significant global funding gap remains for the upstream aspects of disaster resilience building, particularly in respect of the critical roles of NGOs and the private sector.

What are others doing in the Sahel?

60. The 2012 food crisis in the Sahel, following the 2011 Horn of Africa food crisis, led to increasing international attention on resilience and unanimous agreement that current approaches in the Sahel have failed to end the cycle of hunger and that greater efforts are needed on resilience in order to reduce the impact of future food crises. The most significant international initiative is the Alliance Globale pour l'initiative Résilience-Sahel (AGIR-Sahel), formed during a high level consultation in June 2012 of Sahel governments, regional organisations, multilateral organisations and donors. The US, France and the EU have all been actively engaged in the AGIR process. AGIR developed a four pillar road map for building resilience in the Sahel, particularly in Burkina Faso, Niger, Chad and Mauritania. BRACED will particularly contribute to pillar three; *Increasing food production, the incomes of vulnerable households and their access to food in a sustainable manner*.

61. All the main UN agencies working on food security, nutrition and humanitarian response in the Sahel, notably OCHA, UNDP, WFP, FAO and UNICEF, are now prioritising resilience and developing resilience strategies and programmes. WFP, UNICEF and FAO, the main UN agencies working on food security and nutrition, are starting to work together to tackle the root causes of under-nutrition as well as to respond to current cases of chronic and acute malnutrition.

62. A large number of International NGOs have resilience programmes in the Sahel, and have been piloting innovative approaches. Operational research by these NGOs has demonstrated the effectiveness of early action and a new approach to resilience building – 'integrated resilience building'⁵⁹. This has been demonstrated through new conceptual frameworks including the Africa Climate Change Resilience Alliance (ACCRA) and the Local Adaptive Capacity Framework (LAC)⁶⁰, which is now enhancing the effectiveness of adaptation, DRR and resilience programming. The Sahel Working Group, an informal inter-agency network, and Regional Learning and Advocacy Programme (REGLAP) for Vulnerable Dryland Communities represent other specialist consortiums that are supporting integrated resilience approaches and their focus on all sectors and levels of government⁶¹.

63. The Sahel Working Group have developed a strategy for resilience in the Sahel based on lessons learnt during the 2010 crisis. NGOs in particular have led in lesson-learning and innovation in their work in the Sahel and the Horn of Africa, and many are already implementing programmes to build resilience at the community level. BRACED will provide grants to these NGOs to scale up their activities, which have the potential to be replicated and scaled in West and/or East Africa⁶².

64. An evidence paper⁶³ (summary in Box 5) prepared for this Business Case found that there is a clear

funding need for NGO partners to scale-up resilience-building, adaptation and DRR activities in the Sahel. The review also recommended grants of between £1m and £10m as an appropriate scale for NGOs to absorb effectively and to deliver a fast and significant increase in the number of people being supported to cope with the impacts of climate change.

Box 5: Potential of NGOs to build resilience to climate extremes

International non-governmental organisations (NGOs) were invited to engage in the stakeholder consultations. These included Action Aid, CAFOD, CARE International UK, Christian Aid, Concern Worldwide, Oxfam GB, Plan International, Practical Action, Save the Children, Tearfund, Water Aid and World Vision. This group was selected based on their membership of the BOND Development and Environment NGO Group.

The NGO focal points provided details of current and planned resilience-building initiatives in Burkina Faso, Chad, Mali, Mauritania and Niger, as well as Ethiopia, South Sudan, Sudan, Somalia, Kenya, Uganda, Tanzania, Mozambique, Nigeria, Malawi, Zimbabwe, Nepal, Burma, Pakistan, and Bangladesh. Financial, policy and institutional challenges of existing programmes were communicated and potential activities that could potentially be scaled-up through the BRACED programme shared. The review estimated a financial gap of more than £378 million for resilience-building projects and programmes in the focal countries.

The NGO consultation was used to produce an illustrative pipeline portfolio. The data on funding gaps and numbers of beneficiaries were from a small sample of NGOs and hence the figures are indicative of activities BRACED could fund.

Absorptive capacity varies and larger NGOs have the capacity to manage grants of up to £10million over three years. Other NGOs consider the optimal grant sizes are £0.5 - £2.5 million for single-country three year project.

There is a larger average and range of optimal grant sizes for the multi-country projects versus single country projects. The average grant size for a single country project was £2.8 million over three years while for a multi-country project of three or four years duration is £8.2million. The ranges was from £0.3 million to support activities by NGOs operating in Mozambique, Malawi and Zimbabwe, to £48.5m for a new programme integrating child-centred disaster risk reduction across several fragile and conflict-affected countries in the Sahel.

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² In this case including earthquakes as well as floods, droughts and storms, though earthquakes remain the most stable through time of the 4 phenomena

³ Natural Hazards, UnNatural Disasters, The Economics of Effective Prevention, (summary booklet) 2010, World Bank

⁴ Defined as non-OECD countries. Source: EMDAT EM-DAT: The OFDA/CRED International Disaster Database

⁵ Munich re

⁶ IPCC SREX Extreme Events Report (2011) Summary for Policymakers page 6

⁷ See UN-ISDR (2009) and Peduzzi et al (2011).

⁸ Source: EMDAT: The OFDA/CRED International Disaster Database

⁹ Foresight: Reducing Risks of Future Disasters (2012). Final Project Report. The Government for Science, London

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- ³³ Coumou, D. and Rahmstorf, S. 2012. A decade of weather extremes. *Nature Climate change*. doi:10.1038/nclimate1452
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Flag A: Sahel resilience adaptive social protection programme: evidence underpinning the intervention

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1. The positive benefits of social protection

1.1 Social protection leads to poverty reduction

- 1. International evidence shows that targeted social protection interventions directly reduce poverty and inequality.** Old age pensions in South Africa have reduced the poverty gap ratio between the richest and the poorest citizens by 13%. At the same time, the country’s comprehensive system of cash transfers has doubled the share of national income that the poorest 20% of the population receives. In one of the most notable examples globally, Brazil has experienced a remarkable reduction in inequality –

driven largely by a reduction in extreme poverty. Studies have found that *Bolsa Familia*, the largest conditional cash transfer program in the world, was responsible for 21% of this decline in national inequality, while having no negative impact on economic growth.

2. **Evaluations of cash transfer programmes show that social protection directly increases access to basic services and reduces vulnerabilityⁱ.** There is robust evidenceⁱⁱ from numerous countries that cash transfers have leveraged sizeable gains in access to health and education services, as measured by increases in school enrolment (particularly for girls) and use of health services (particularly preventative health, and health monitoring for children and pregnant women). Cash transfers also have a proven role in supporting specific vulnerable groups (people living with HIV and AIDS, orphans and vulnerable children)ⁱⁱⁱ.

Conclusion: evidence that social protection can reduce poverty is strong.

1.2 Social protection leads to the accumulation of productive assets

3. Social protection can protect assets, smoothing consumption and incomes during shocks.
 - Kenya's *Hunger Safety Net* beneficiaries maintained standard of living during the 2008 -11 droughts. Expenditure by those not covered dropped by 10%
 - Despite experiencing widespread drought and other weather related shocks, large increases in input prices, as well as difficulties in accessing input markets, households enrolled in Ethiopia's Productive Safety Net Programme maintained or increased their standard of living between 2004 and 2010. 62% of participants avoided selling assets. 36% avoided using savings to buy food. 23% of participants acquired new household assets.
4. It can help people to accumulate assets, raising incomes and leading to graduation from social protection
 - Bangladesh's *Challenging the Frontiers of Poverty Reduction* programme increased per capita income by 42% & doubled household assets. The approach is now being tested in 12 other countries and showing promising results.
 - The Kenya Orphans and Vulnerable Children's programme reduced poverty by 13% and enabled households to accumulate productive assets, particularly small livestock.
5. Building community assets that reduce vulnerability to climate shocks through public works. Strong positive experience at scale from Rwanda, Ethiopia and Bangladesh.

Conclusion: evidence that social protection can lead to the accumulation or retention of productive assets is strong.

1.3 The links between social protection and economic growth

6. The International Labour Organisation (ILO) has done extensive modelling to demonstrate that social protection and social security schemes do not retard economic growth but are actually associated with higher rates of growth over time in Africa, and help promote access to education, health care, and even enhanced gender equality.^{iv}

7. Evidence shows social protection raises incomes, encourages small investments and rarely discourages adult labour supply.^v Small but reliable flows of transfer income have helped poor households to accumulate productive assets, avoid distress sales, access credit on better terms, and in some cases to diversify into higher risk, higher return activities.
8. As well as protecting assets social protection can stimulate local markets (recent evidence from Kenya on this). There is some evidence from Zambia and Namibia that the introduction of cash transfers into poor, remote areas can stimulate demand and local market development.^{vi}

Conclusion: there is some evidence linking social protection to economic growth at the local level, but the evidence base is limited.

1.4 Scalability of social protection in a crisis

9. There is strong evidence that a faster response is possible when existing instruments are used instead of developing new ones, although the evidence from LICs and FCAS is more limited. Ethiopia’s Productive Safety Net Programme (PSNP) includes a risk financing mechanism (RFM) that allows the programme to be scaled up in the event of a shock. The time between the request for PSNP risk financing resources and disbursements was six weeks in 2011. See Box 1 for further details of the speed of the Ethiopian risk financing mechanism response.

| |
|---|
| <p>Box 1: Ethiopia’s PSNP’s Risk Financing Mechanism</p> <p>2011 saw a major drought affecting a number of countries across the Horn of Africa, including Ethiopia. A humanitarian appeal was launched in March 2011, five months after the semi-annual seasonal assessment was completed. While the March appeal resulted in some resources being made available for the response, as of December 2011 (nine months after the appeal was launched and some 13 months after the original assessment), 94 % of the funding for the humanitarian appeal was in place. By contrast, in August 2011, when regular PSNP transfers stopped, the risk financing mechanism (RFM) completed a rapid verification of needs in highland areas within a month of the request for RFM resources, and financing was disbursed within two weeks of the request. From request to disbursement took six weeks. This shows that, when the preconditions are met, the RFM easily outperforms the humanitarian system in terms of verifying needs and disbursing resources for a response to be delivered through government systems. While an assessment is required to determine the impact of the RFM on livelihoods, the RFM’s early and preventive response to an identified need means that it has a far higher chance of helping affected people not to resort to negative coping strategies and asset depletion as a response to a shock.</p> <p>Source: <i>Ibid.</i></p> |
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10. Putting a system in place and building resilience before a crisis hits is more cost-effective than responding later with a humanitarian response (every USD1 spent on disaster resilience resulted in benefits, in the form of reduced humanitarian spend, avoided losses and development gains, of USD2.8 in Ethiopia and USD2.9 in Kenya^{vii}).
11. The World Bank’s Rapid Social Response fund is designed to be able to quickly channel additional contributions from donors focused on basic service protection in times of

crisis – commitments can be made within 2 months of resources becoming available. Examples include:

- Gambia - Rapid Response Nutrition Security Improvement Project (\$3.2m) supports the National Nutrition Agency in mitigating the impact of the global economic crises on the nutrition security of children under two and pregnant and lactating women in poor rural and urban areas.
- Gender-Based Violence in Post-Earthquake Haiti (\$581,000) aims to contribute to preserving the safety of women and girls and addressing the extreme increases in Gender-Based Violence in post-earthquake Haiti through proven community-based interventions.

| RSR grants for the protection of access to basic services in times of crisis Dec 2009 and 2012 | Total Cost | N. of Countries(*) |
|--|--------------|--------------------|
| a) Providing nutrition benefits | \$8,612,325 | 10 |
| b) Providing other forms of social assistance benefits | \$7,551,700 | 5 |
| Total | \$16,164,025 | 15 |

Conclusion: evidence that when an effective and appropriately designed social protection system is in place it can be used to scale up in response to a crisis. The evidence is weaker on social protection programmes that have been able to do this in LICs and FCAS.

1.5 The political benefits of social protection in fragile/conflict affected States

12. There is a small body of evidence that indicates that in fragile and conflict-affected countries, social protection may play an important political role. Effective social protection can help to strengthen the social contract between the state and citizens, consolidating state legitimacy and effectiveness.^{viii} There are good examples from Philippines, Nepal and Sri Lanka. Findings relevant for the Sahel are promising^{ix}:
- In northern Kenya, the DFID-funded Hunger Safety Net cash transfer programme helped communities hold local government to account e.g. provision of boreholes to increase access to safe water; and created an incentive for people to apply for national identity cards, leading to increased electoral enrolment.
 - In Liberia and Sierra Leone, World Bank, EC and AfDB-funded public works programmes focusing on destitute youth, including ex-combatants, are reported to have increased integration in society and social cohesion^x.
 - Cash transfers increased community solidarity in Uganda, Kenya, Yemen and Occupied Palestinian Territories by enabling previously marginalised people (youth, OVCs, divorced and widowed women) to participate in community events and decision making. Beneficiaries reported feeling stronger citizen-state ties as a result of their participation in state-delivered social protection in Kenya and Uganda^{xi}.
13. Until recently, cash transfers have not been a common choice in post-conflict programming, and in-kind transfers, such as food-aid, agricultural inputs and basic necessities have dominated. This has been, in part, due to concerns about the feasibility of delivering cash, including concerns over creating inflation in weak markets, choice of targeting methodologies (e.g. universal targeting can be less divisive than poverty targeting), and the appropriateness of cash as a social protection instrument. Positive experiences in Somalia suggest these constraints can be overcome through design choices and good supervision.^{xii} In Nepal, cash transfers have been provided to the

elderly, disabled and widowed since the mid-1990s, and delivered even during the conflict^{xiii}.

Conclusion: the evidence on the political benefits of social protection is limited. Evidence shows that it is possible to deliver social protection programmes in fragile and conflict affected environments.

1.6 The benefits of social protection for building climate resilience

14. There is little evidence of the benefits and costs of social protection schemes designed specifically for disaster risk reduction and building climate resilience.
15. Davies, Oswald and Mitchell^{xiv} explored the concept of adaptive social protection and concluded that there is a need further to develop an evidence base on how effectively to combine social protection measures to mitigate vulnerability to climate change in different contexts.
16. One of the few examples comes from the Chars Livelihoods Programme in Bangladesh which used community public works, to raise more than 100,000 homesteads on the riverine chars above flood levels and transferred productive asset transfers to flood-prone households. A DFID study concluded that the plinths had a benefit to cost ratio of 4.3 to 1 and the assets 7.9 to 1^{xv}.
17. There is some evidence on the impact of insurance against losses from natural disasters^{xvi}. Linnerbooth-Bayer and Mechler (2009) cited examples of positive benefit:cost ratios for insurance against natural disasters. Many, but not all, were from developed countries. However, they highlighted that the record of insurance for providing security against floods, earthquakes and other hazards is more tenuous than other forms of insurance, in part because of the potential scale of the losses. Early experience with index-based crop and livestock insurance suggests that it can be a cost-effective alternative to indemnity-based agricultural insurance. Other authors also concluded that pilot (insurance) programmes should be carefully monitored^{xvii, xviii}.

Examples of how adaptive social protection can build climate resilience:

18. **Well-designed public works projects have the potential to substantially improve the local environment.** Eg Ethiopia PSNP: Public work projects were focused on soil and water conservation (e.g. check dams, drip-fed irrigation etc.). This makes PSNP one of the largest environmental management programmes in Africa.
19. **Well-designed public works can have clear disaster risk reduction, food security and climate change adaptation impacts as they reduce exposure and sensitivity to natural disasters** - for example droughts and floods - improve soil productivity and increase the amount of land that can be cultivated. Eg Rwanda : The Vision 2020 Umurenge Program's public works projects are dominated by anti-erosive ditches and 'radical' hillside terraces which explicitly aim at environmental protection. Such public works have clear disaster risk reduction, food security and climate change adaptation impacts as they reduce exposure and sensitivity to natural disasters - for example droughts and floods - improve soil productivity and increase the amount of land that can be cultivated.

20. **Weather indexed crop insurance:** As climate impacts become increasingly critical to agriculture production in developing countries due to climate change, insurance is likely to play a greater role in absorbing shocks and spreading risk. In recent years there has been a shift away from insuring against poor crop yields toward insuring directly against bad weather. Weather-indexed crop insurance develops a contract written against an index establishing a relationship between lack of rainfall and crop failure, verified by long historical records of both rainfall and yields. Farmers collect an immediate payout if the index reaches a certain measure or ‘trigger’, regardless of actual losses, so farmers still have an incentive to make productive management decisions. This removes moral hazard and adverse selection problems inherent in crop insurance (Hellmuth *et al.* 2007; Hess and Syroka 2005; Pierro and Desai, this *IDS Bulletin*). **When well designed, they may also permit farmers to enhance adaptive capacity through greater risk-taking experimentation in agriculture practices not possible in crop insurance schemes.**
21. **Asset restocking:** A sustainable strategy for disaster reduction must focus on activities to help the vulnerable build assets (UN-ISDR 2004; Wisner *et al.* 2004; Vatsa 2004) which incorporate climate screening in order to ensure that such assets are able to support resilience in a changing climate (Tanner *et al.* 2007). Social protection measures can contribute to asset accumulation, for example through unconditional and conditional cash transfers, micro-credit as well as the direct provision of livestock or poultry through asset transfer programmes. The Reducing Vulnerability to Climate Change (RVCC) project has explicitly mainstreamed climate change throughout its design and implementation. One adaptation strategy identified by the programme is the need to promote alternative livelihoods. **The project encouraged the uptake of assets such as duck-rearing which would enhance income and prove to be resilient in the face of climate change** (Mallick 2006).
22. **Seed distribution: In response to calls to develop and distribute crop varieties that are drought and saline resistant, programmes for the distribution of free inputs or inputs-for-work have become a common response among development agencies.** The distribution of fertiliser and seeds for free is intended to enhance food security by boosting food production among farmers who are unable to obtain such inputs. As an alternative to traditional input distribution programmes, DFID has supported Catholic Relief Services (CRS) along with the Food and Agriculture Organization (FAO) and other local partners to implement a seed voucher and fair programme to 35,000 households throughout Kenya’s semi-arid region in response to prolonged drought. Beneficiaries were given vouchers to purchase seeds at locally organised seed fairs. Farmers and local traders were encouraged to bring their surplus seeds to fair sites where voucher holders were able to select seeds of their choice. On completion of the seed fair, seed retailers redeemed their vouchers for cash. In contrast to the package of inputs approach, which can undermine biological diversity and leads to mono-cropping (Thompson *et al.* 2007), seed vouchers and fairs have encouraged farmers to maintain crop diversity on their farms, contributing socio ecological resilience. Seed voucher and fair projects present a cost-effective way to assist post disaster recovery and enhance resilience by promoting crop diversity and information sharing between farmers.

Conclusion: there is currently limited evidence linking social protection specifically to building adaptation to climate change. There is, however, a growing level of interest and research in this area which should build the evidence base.

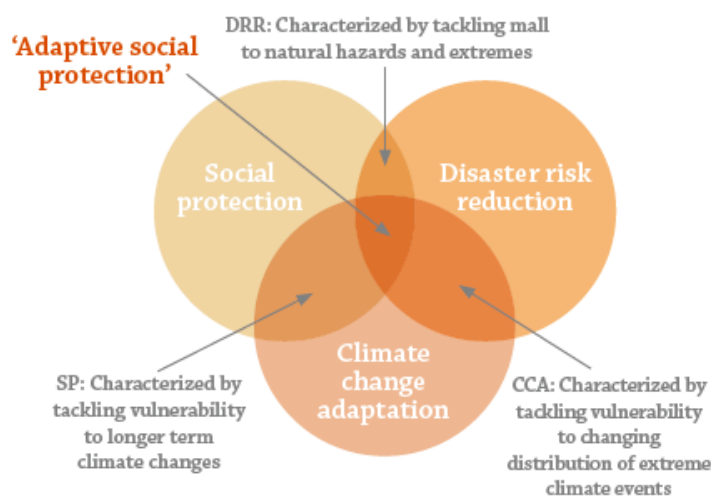
| Time frame | SP category | SP instruments | CCA and DRR benefits |
|------------|---|---|---|
| Short-term | Protective (coping strategies) | <ul style="list-style-type: none"> Social service protection Basic social transfers (food/cash) Pension schemes Public works programs | <ul style="list-style-type: none"> Protection of those most vulnerable to climate risks, with low levels of adaptive capacity |
| | Preventive (coping strategies) | <ul style="list-style-type: none"> Social transfers Livelihood diversification Weather-indexed crop insurance | <ul style="list-style-type: none"> Prevents damaging coping strategies as a result of risks to weather-dependent livelihoods |
| Long-term | Promotive building adaptive capacity) | <ul style="list-style-type: none"> Social transfers Access to credit Asset transfers/protection Starter packs (drought/flood resistant) Access to common property resources Public works programs | <ul style="list-style-type: none"> Promotes resilience through livelihood diversification and security to withstand climate related shocks Promotes opportunities arising from climate change |
| | Transformative (building adaptive capacity) | <ul style="list-style-type: none"> Promotion of minority rights Anti-discrimination campaigns Social funds | <ul style="list-style-type: none"> Transforms social relations to combat discrimination underlying social and political vulnerability |

Source: Adapted from Davies et al. 2009

xix

Figure 2a. The conventional way to represent the interactions between the three domains

Fig



xx

1.7 The links between women's empowerment through social protection and building resilience

23. Empowerment of women is an important ingredient in building climate resilience with examples from a wide range of countries on how empowering women communities contributes to climate resilience^{xxi}. There is also strong and mounting evidence at the country level that improving gender equality contributes to policy choices that lead to better environmental governance, whether through increased representation and voice of women within their communities, in society at large, and at the political level, or

through increased labour force participation. In Nepal and India women's participation in forest committees beyond a critical minimum threshold (around a third) has been seen to have a positive impact on forest regeneration and a reduction in illegal extraction of forest products^{xxii}

24. There is evidence that where women are empowered to expand their own, their families' and their communities' endowments, agency and opportunities, this can also serve as a powerful springboard for building climate resilience. Good examples of how this can be done are seen in programs that seek to build climate resilience through gender sensitive approaches to supporting rural livelihoods. In pastoral communities in Kenya and Ethiopia building resilience to drought, with a particular emphasis on empowering women to become agents of change, helped communities better manage the risks associated with the 2005–08 drought cycle by generating income, preserving assets and enhancing food security.^{xxiii}

Conclusion: there is medium evidence that there are links between empowering women through social protection and building resilience.

1.8 Case study: the benefits of social protection in Northern Kenya

25. **A randomized control trial HSNP 1^{xxiv}** facilitated a better understanding of how CTs are used and the impact they have for the pastoral households in the ASALs of Northern Kenya. Early evidence^{xxv} looking at impacts from one follow up round suggested that relative to the control group, the impacts of HSNP1 were:
- i. **Increased poverty reduction and a slower slide into poverty in crisis years:** During the high levels of drought and price inflation in 2011, poverty incidence did not increase among HSNP beneficiaries but did amongst control households – where a significant increase in poverty rates was detected – suggests that the HSNP is performing its function as a 'safety net'.
 - ii. **Increased food consumption and improved dietary diversity:** An increase in the consumption of food by recipients of the cash transfers with 69% of beneficiaries reporting that they have been able to have more and/or larger meals since receiving the HSNP cash transfers. Beneficiaries are consuming more diverse diets since the programme started – especially poorer households, for whom the cash transfer adds more value relative to total household monthly income, and smaller households which receive a higher per capita transfer value per month. Beneficiaries also report that since receiving the cash transfers they have been able to have more and/or larger meals, and express a clear preference for cash support in contrast to food aid. Large and partially settled HSNP households are also less likely to receive supplementary feeding.
 - iii. **Increased household retention of productive assets:** Decline in productive asset retention amongst beneficiary households (15%) has been much less than in control groups (42%). HSNP households are more likely to have retained their livestock, especially goats, than control households, who lost livestock during the drought. Beneficiaries valued the fact that HSNP transfers allowed them to buy food with this cash, rather than selling their animals to cover essential spending needs, which would otherwise have been unavoidable.
 - iv. **Uptake in credit:** Increased from 55% to 75% of households.
 - v. **Changes in work patterns:** 20% of households reported positive changes to work patterns as a direct result of cash transfers.

- vi. **Health expenditure:** 11% of households reported spending some of the transfers on health related consumption^{xxvi}.
- vii. **Education expenditure:** 20% of beneficiary households also reported increased expenditure on education.

2. Evidence on the benefits of different forms of social protection:

2.1 The role of cash transfers in delivering improved welfare, resilience and socio-economic impacts for households

26. **DFID has been a thought leader in CTs globally and has provided much of the evidence to support improved processes and practices**^{xxvii,xxviii,xxix}. There has been a rapid growth in CT programmes globally, and these are now estimated to reach between 0.75 and 1 billion people^{xxx}. The evidence for the impacts of CTs in reaching the poor is increasing^{xxxi}. DFID’s *Cash Transfers Literature Review* published in 2011 highlights the growing evidence on the impact of social protection schemes in reducing poverty and vulnerability. There is now more substantial evidence that well-designed and carefully implemented schemes have also resulted in other development gains, from human development to women’s empowerment and economic inclusion and growth.

27. Evidence of social cash transfer impacts from *DFID Cash Transfer Literature Review 2011*:

| Gradation of evidence for outcomes of cash transfers | |
|---|---|
| Raising living standards of the poor <ul style="list-style-type: none"> • directly reduces poverty, hunger and inequality • helps households sustain and improve livelihoods in the face of vulnerability and shocks | Very consistent evidence |
| Human development / human capital <ul style="list-style-type: none"> • improves quantity and quality of food consumption (child nutrition and development) • helps households make use of health and education services (meeting access costs, reducing need for child labour and school dropout) | Growing body of positive evidence |
| Economic development and inclusive growth <ul style="list-style-type: none"> • facilitates structural reforms supporting long-term growth • helps households to escape low risk, low productivity poverty traps • frees up household savings for investment • raises household spending with local multiplier effects and (in MICs) potential for fiscal stimulus role | Strong logic, to date limited evidence |
| Empowerment and gender equality <ul style="list-style-type: none"> • empowers women within households and communities • empowers poor individuals and households to make their own decisions for improving their lives. | |
| Climate change and natural disasters <ul style="list-style-type: none"> • help reduce and mitigate risk of environmental shocks (e.g. through public works and diversification) and cope with shocks that do occur | |
| Facilitating social cohesion and state-building <ul style="list-style-type: none"> • reduce inequalities that contribute to social fragmentation, crime and political instability | |

28. Despite this evidence in favour of cash transfers at a local level, this is only the case where markets are functioning well. There is still uncertainty about the capacity of markets to respond positively in more remote rural areas that are a long way from business centres. Some of the most vulnerable people would be unable to travel far to market and for such groups there are advantages in other in kind distributions as part of providing social protection. The extent of the private sector response to meet the shortfall, and its limitations in reaching those in needs in terms of availability and cost of additional grain distributed would need to be carefully assessed.
29. Cash is seen as more open to political manipulation. Even those in favour of cash based approaches would caution against cash in envelopes as a delivery mechanism in an increasingly politicised environment. Electronic transfers or a voucher system with local traders can be better option and less open to political capture. However, the problem is that although there have been some successful pilots on e-transfers, such as using debit cards, these could not be scaled up quickly at a national level. There is neither the banking nor telecommunications infrastructure in place yet to do this at scale particularly in rural areas. There is certainly potential to do more on e-transfers, especially in areas closer to urban centres, but the coverage would be limited in terms of numbers affected.

Conclusion: there is strong evidence that cash transfers are an effective form of social protection

2.2 Evidence on the benefits of using alternative forms of social protection (cash transfers and public works programmes) rather than food aid

30. In situations of chronic food insecurity in which a base annual level of food insecure households is largely predictable, emergency food aid will generally constitute a costly and inefficient response to hunger. By contrast, institutionalised cash transfers confer the advantages of greater timeliness and predictability (valuable to both planners and recipient households), flexibility and (generally) net positive effects on local agricultural production and market development. These policy calculations have underpinned a shift from food aid to cash transfers in a number of countries. Ethiopia's PSNP grew out of a desire, by both Government and donors, to replace inefficient food aid based on annual emergency appeals aid with institutionalised public works and other transfers. Similar calculations suggest economic gains from switching from food aid to cash transfers in a number of countries, including Nepal and Kenya. In the latter, it is estimated that cash transfers would cost considerably less (US\$ 55 pc pa) than food aid (US\$ 79 pc pa). [Source: Holmqvist 2010]
31. **Food aid has historically played a very important role in responding to humanitarian crises and is generally credited with saving lives in these situations.** However, given this focus on emergency response, there is, to date, no robust evidence of the impact of food aid on beneficiary households or the communities^{xxxii}. There is some suggestion that these interventions result in improved food and nutrition security among beneficiary households and improved diversity in crops planted, but these findings do not compare these outcomes as compared with a control group and the latter may be a result of the public works activities under the food for assets programme.

32. **Between 2005 and 2010, a total of Ksh 17.8 billion was channelled to Kenya's safety nets, 41% or KSh 7.3bn was food aid. The WFP Protracted Relief and Recovery Operations (PRRO)^{xxxiii} focuses on the ASALs and will spend US \$424.5 million between May 2012 – April 2015 (\$141.5m or £93.1m) a year.** In 2010, an estimated 35% of all safety net beneficiaries were receiving support from the WFP General Food Distribution Programme, the main programme under PRRO. Evidence suggests that while PRRO has had the ability to scale up in response to shocks, this tends to be driven by levels of donor support in cash or kind and it is less good at scaling down^{xxxiv}. The non-transfer costs for the PRRO as a proportion of total expenditure were consistently higher than the average for other safety nets in Kenya (51% for the period 2005-2010 as compared with 24% for all other safety net programs)^{xxxv}.
33. **Cash transfers tend to be cheaper and faster to deliver than food aid^{xxxvi}.** Food aid often has to be procured internationally, but even when it is procured locally, it can take several months before procurement processes are completed. The delivery of food aid also involves significant costs and takes time, whereas cash transfers sent through the banking system tend to be much faster. For example, evidence suggests that for every \$100 spent, a much higher proportion of that \$100 ends up in the hands of beneficiaries under a cash transfer program compared to a food program. This is a consequence of the transport, handling and storage costs of food (whether domestically or internationally purchased) and the fact that food for such programmes is often procured internationally at a higher cost (once delivered to a domestic port) than it can be purchased in local markets^{xxxvii}.
34. **Cash allows households to spend money where they need it.** This means they can spend money on a more comprehensive food basket rather than standard rations, as well as meeting other needs (e.g. health, education etc.) The combination of lower costs and faster speed means that the cash has a greater impact in terms of smoothing consumption and protecting livelihoods per dollar spent^{xxxviii}. Food shortages are most commonly the result in constrained access to food rather than an absolute lack of availability of food. Provision of food is responding to an availability failure (which rarely exists) rather than an entitlement failure (which frequently exists)^{xxxix}. Cash usually reduces the opportunities for corruption because it provides greater accountability than transfers in food. Cash doesn't 'fall off the back of a lorry' or get 'infested by pests' etc. Audit trails for cash go all the way to the beneficiary – for food they frequently focus on procurement of food and transportation with less focus on what happens to food after that.
35. **However, there are risks.** Cash is significantly at risk of food price inflation and is more subject to 'reductions in ration size' in real terms than food. Cash tends to have a less significant consumption smoothing affect than food. Its greater fungibility means that a higher proportion of CTs are used for other household expenditure. Women tend to have more decision making power over the use of food transfers compared to CTs.

Conclusion: there is medium strength evidence on the impact and utility of cash transfers relative to food aid.

2.3 Evidence on the effectiveness of Public Works Programmes

36. In 2009, McCord, A. and Slater, R. concluded that “the limited availability and poor quality of primary data from 167 PWP on programme cost, outputs, outcomes and the

socio-economic profile of programme participants limit the potential for addressing questions of cost, targeting or impact in the region”^{xi}. The Ethiopian Productive Safety Nets Programme, which uses PWPs as the basis of social protection, is providing valuable new evidence on the impact of public works programmes.

37. The Ethiopia PSNP implements “proactive social protection measures^{xii}. It addresses the needs of food insecure households through multi-year predictable resource transfers; preventing asset depletion at the household level and creating assets at the community level. It has two components;

- Labour intensive public works; Enhance community assets; schools, clinics and roads; and
- Direct support. Direct food or cash transfers.

38. **Headline findings from PSNP-** key messages from the draft programme performance report based on the mid-2012 data are^{xiii}:

- Results from the October 2012 round finds **significant improvements in PSNP operations** when compared to 2010: payments are larger, more timely, consistent with programme principles (e.g. reflecting family size), though still not sufficiently predictable. Targeting has continued to improve since 2010.
- **Graduation – local officials moving people off the programme - is still inconsistently understood and applied.** It does however appear to be slowing down, suggesting that the target-driven approach that worries donors may be easing off.
- **Public works** built by the programme are perceived by beneficiaries and officials alike to have had significant positive impact. Putting together responses from beneficiaries and the findings from the separate Public Works Impact Assessment, we see PSNP public works contributing to: improved access to health and education, and contribution to rehabilitation of degraded natural environments (reduction in flooding and soil erosion; recharging groundwater and earlier seasonal springflow; reforestation) with benefits for livelihoods (e.g. honey production and cut-and-carry animal foster from terraced and enclosed hillsides).

39. The **Impact Assessment** of the Ethiopia PNSP is still in the pipeline, including the critical data on outcomes and impact of the programme on food security. Preliminary analysis suggests significant improvement amongst the sample – maybe a halving of the food gap – with a significant proportion of this attributable to programme impact. Additional and rather complex analysis will then be needed to tease out how much of this is attributable directly to PSNP.

Conclusion: evidence on the effectiveness of public works programmes is limited.

3. Evidence on methodologies for building social protection systems

3.1 The use of TA in national social policy and sectoral reform processes

40. **Use of TA to influence national policy and sectoral reform processes:** The aid literature suggests that TA is difficult to deliver well – and historically has often been ineffective^{xliii}. The Accra High Level Forum on Aid Effectiveness (2008) identified factors that contribute

to effectiveness of technical cooperation, including management capacity which can progressively shift TA towards country systems and a focus on the processes of capacity building^{xliiv}. A review of evidence on health TA for DFID in 2007 suggests that success is highly context, culture and time specific^{xliv}.

41. **DFID's influencing work is closely linked to our TA – often we use TA as a practical means for gathering and providing evidence for informing better policy making.** Contrary to the aid literature, DFID's recent Country Programme Evaluations are generally positive about DFID's sectoral TA. The evidence^{xlvi} highlights the need for any TA to be: (i) Country led; (ii) Coordinated; (iii) Market-based; and (iv) Fully pooled. For example, in health, TA has strengthened capacity to develop health policy (Pakistan, Zambia, and Kenya) and flexible use of short-term technical support has responded well to demands and been able to inform the policy agenda (Ethiopia). The DFID health portfolio review found that influencing appears likely to be very cost-effective, although a full quantitative cost-effectiveness analysis of influencing is likely to remain impractical. In the case of governance and public service reform (PSR), evidence shows that TA has worked best in countries where there has been a significant degree of ownership and direction from the recipient country^{xlvii}.
42. **Use of TA to influence national social policy and sectoral reform processes:** A major evaluation of 10 years of World Bank support to Social Safety Nets (SSNs) (2000-2010) was recently published.^{xlviii} It noted that over the decade, the Bank began to move from a project-focused approach that emphasized delivery of social assistance benefits, toward an approach that focused on helping countries build SSN systems and institutions to respond better to poverty, risk, and vulnerability. It underscored the importance of a country-specific and time-varying blend of lending and **all forms of non-lending support: formal economic and sector work, non-lending TA, capacity building through training or South-South learning, involvement in donor coordination or impact evaluation**. Specifically, the provision of long term knowledge and TA support was seen as an essential investment alongside operational assistance. This was often provided most effectively through multi-donor trust funds. It concluded that the Bank should focus on strengthening its engagement in low-income countries, emphasizing lending and non-lending (TA) instruments that support SSN systems and institutional capacity, and improving the results frameworks of operations that support the development of SSN systems.
43. **International experience would indicate that if social protection policy is to be influenced, it is critical to engage successfully with Ministries of Finance.** The introduction of the old age pension in Lesotho – at a cost of over 1% of GDP – was an initiative of the Minister of Finance. In Kenya, recent increases in budget allocations for social protection have emanated from the Ministry of Finance and not from Line Ministries, following years of capacity development of key staff in the Ministry, supported by development partners. A recent political economy study in Uganda has indicated the key role of senior civil servants in the Ministry of Finance in blocking increases in social protection budgets, despite support for budget increases from Parliament and a number of Ministers.^{xlix} In Tanzania, in 2010, a proposed DFID programme to finance an old age pension – which had strong support from the Ministry of Labour – was blocked by the Ministry of Finance.
44. **DFID's use of TA to support SPP1 in Kenya has delivered results:** From a baseline where there was no social protection policy in place (2007), the right to social protection is now

enshrined in the new Constitution, and the NSPP has now been agreed by the GoK Cabinet. A recent study of the social protection sector, carried out by the Ministry of State for Planning, National Development and Vision 2030 (2012), jointly funded by the World Bank, DFID and UNICEF, provides an overview of the current status of the sector and identifies the complexities, evolution and challenges. It reviewed 22 of the larger programmes, including DFID programmes which are two of the largest, with total financing to KSh 75 bn. This notes the utility of DFID TA provision for social protection policy support under SPP1 and underpins the rationale for TA support to NSNP development and delivery.

45. **Uganda's Expanding Social Protection Programme which recently underwent a mid-term review (Ashley et al. 2012).** It has 16 consultants providing technical assistance within the Ministry of Gender, Labour and Social Development (MGLSD). Despite delays in commencing the programme, on the three outputs related to capacity building, policy development and building awareness among policy-makers it was rated A+, A and A++. Key to its success was the quality of the consultants contracted. However, the programme has been less successful in influencing budgetary commitments on social protection, in part due to resistance from within the Ministry of Finance despite efforts to influence it from outside. There is also no evidence that government staff in the MGLSD could engage independently without technical assistance support or additional incentives provided by the programme, although this should not be expected after only two years.

Conclusion: The evidence indicates that technical assistance can be successful in bringing about meaningful change, as long as it is provided by good quality consultants over a sufficient period of time. If the aim is to influence social protection policy and sustainability it is important to gain the support of the Ministry of Finance and other powerful Ministries.

3.2 Lessons on the use of pilot schemes to develop social protection programmes

46. **Using pilot schemes to assess the cost of social protection programmes:** Data from pilot schemes can be less than ideal for assessing the long-term feasibility of domestically-financed national equivalents: unit costs are likely to be much higher in pilots with high initial set-up and learning costs than in institutionalised schemes that can benefit from scale economies (for example, staffing costs in the BRAC TUP declined considerably during the course of implementation as the beneficiary to staff ratio changed from around 50:1 in the first year to 250:1 by the end of the programme). There is also a case that benefits, too, will be higher in intensively-managed pilots than when taken to scale.
47. **Getting government support for pilots:** Where donors do support pilot programmes, they should be especially careful to ensure that these respond to domestic conceptualisations of need and prioritisations of objectives, and that there is tangible evidence of government commitment, usually including through at least some financial contribution. Without this, there is a strong risk that pilots will not be scaled up, whether or not they have proven their cost-effectiveness. Several pilots such as the Hunger Safety Nets Programme in Kenya and the cash transfer programmes in Malawi and Zambia face these risks, despite strong donor advocacy in some cases for governments to co-finance scale-up. It also helps sustainability if pilots help build

skeleton national social protection systems which can be fleshed out as programmes expand, rather than setting up separate systems.

Conclusion: the evidence indicates that pilot schemes are more likely to develop into effective national social protection programmes if strong government commitment is secured early on, and if pilots are designed, built and assessed with scale-up in mind.

3.3 Improving government investment in social protection systems

48. There is limited evidence of effective development partner investment in improving government social protection systems in LICs and FCAS. However, this is mainly because it has only recently been attempted in these contexts. In most LICs there are few examples of large social protection programmes that development partners could help reform. In middle-income countries with large social protection systems – such as South Africa, Brazil and Mauritius – reforms have been led and financed by governments themselves.
49. However, there are a number of developing countries in which development partners are beginning to invest in improving systems. These include Pakistan, Indonesia, East Timor, Fiji, Mongolia, Kenya and Ghana. However, in most cases, it is too early to know whether these reforms will be successful. There are, however, some clear examples of success: for instance, AusAID and UNCDF have significantly improved the delivery of cash in Fiji’s Family Assistance Programme by moving to electronic payment systems (Leonard 2011). In Pakistan, an electronic management information system has been put in place for the Benazir Income Support Programme with support from the World Bank, using biometric identity cards for beneficiaries.ⁱ Sridharan (2012) provides international evidence on the use of electronic transfers, with the introduction of some supported by development partners. Furthermore, there is evidence that advanced systems using new technologies can be established in low-income countries: in Kenya’s HSNP and Uganda’s SAGE programme, DFID has established effective management information and cash delivery systems, although only on small-scale pilot programmes; the World Bank in Bangladesh has helped improve the delivery of the Employment Generation workfare scheme.
50. The success of support to strengthening social protection systems is likely to depend on the degree of complexity in programme design. When administrative capacity is weak, schemes with complex designs are more likely to fail. In Ghana’s LEAP programme and Kenya’s CT-OVC scheme, for example, introducing conditions into programmes proved impossible to administer.ⁱⁱ Indeed, many so-called conditional programmes do not enforce the conditions. Similarly, complex targeting systems introduced into Kenya’s CT-OVC and Pakistan’s BISP could not be implemented consistently and effectively.ⁱⁱⁱ Complexity may also lead to greater chances for corruption. There are strong arguments for keeping systems as simple as possible so as to ensure success, since this allows less potential for corruption and makes monitoring much simpler.
51. Examples from Africa of rising government investments in social protection programmes:

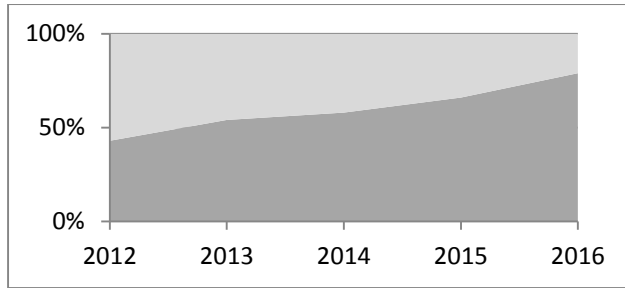


Figure 1: % share of total programme funding from Government in Ghana's LEAP programme

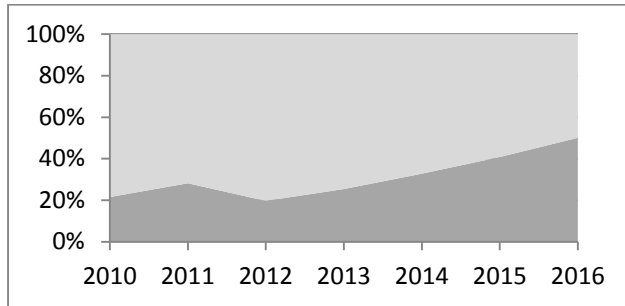


Figure 2: % share of total programme funding from Government in Zambia's social protection programme

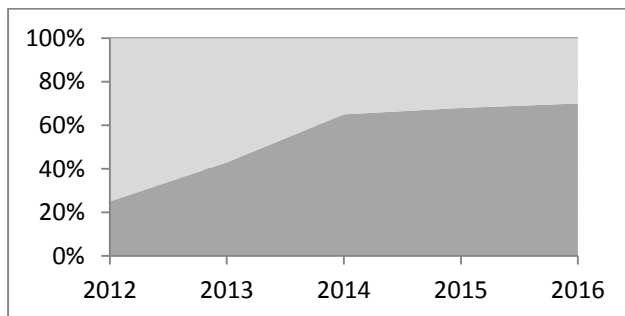


Figure 3: % share of total programme funding from Government in Kenya's CT-OVC programme

Conclusion: There is strong evidence of donors investing in social protection programmes, and a limited but growing body of evidence of donor investment in building social protection systems. There is strong evidence that national governments are prepared to take on increased responsibility for co-financing social protection programmes. This is, however, very context specific, and it is not yet known what the critical factors are that lead to governments to take on more financial ownership.

3.4 How well does national systems building work attract other funding: evidence from the World Bank RSR trust fund

52. The RSR has demonstrated that small catalytic grants that strengthen core components of social protection systems can catalyse increased funding and increased coverage of beneficiaries. At present 36 RSR funded projects in 32 countries (totalling just \$25.52m) are associated with \$2.275bn worth of existing and planned IDA credits and grants. Other grants have Cameroon a grant of \$550,000 from the RSR, supported an assessment of the feasibility of cash transfers and the design of key operational features for a new programme (targeting, beneficiary registry, payments and M&E). This work

has initiated a new social protection programme that will be financed by IDA, with an indicative commitment of \$50m from the Government of Cameroon.

53. Additional coverage based on a review of 6 case studies indicates a potential increase in IDA and beneficiaries within a wide range: from the high case (Cameroon) of additional IDA of £662m and additional beneficiaries of 2,415,162, the average case (across 6 case studies) of additional IDA of £272m and beneficiaries of 992,900 and the low case (Rwanda) of additional IDA of £147M and beneficiaries of 536,703. This analysis is based on a limited sample of case studies that had coverage data (see Annex 3). DFID support to RSR going forward is based on an agreement of more systematic monitoring of the leveraging of social protection spend and increase in beneficiaries.

54. It is too strong to call the current link between RSR and IDA funding 'leverage' as there are many factors at play in any IDA application. But there is evidence in the case study countries that without RSR funds the Social Protection programmes in design would not have been funded through IDA. This suggests that the RSR is a necessary but not sufficient condition for access to IDA credits. E.g. evidence from the RSR management team strongly suggests that the Cameroon social safety nets programme would have been cancelled without the RSR grant. In FY10 (when the RSR project of \$550,000 was approved) and FY11 (July 2010-June 2011), the Africa Region management did not allocate any budget to the task even though the IDA operation was in pipeline. In FY12 (July 2011-June 2012), the AFR management gave \$98,600, and FY13 (July 2012-June 2013), \$142,000. The AFR management only agreed to fund the programme after the RSR project started producing useful materials. It is also the World Bank's view that Dibouti, Guinea and Togo would have dropped out of the IDA pipeline without RSR funding.

Conclusion: there is medium strength evidence that World Bank programmes to build social protection systems in their early stages can go on to attract higher levels of IDA funding.

3.5 Existence and use of initiatives to support the building of the evidence base on social protection (particularly in the Sahel):

55. Use of learning activities by RSR funded programmes:

- South-South Learning Forum – Labour Market Policy Response to the Global Jobs Crisis (\$450,000) in November 2012 focused on Labour and Social Protection policies during the FFF crisis and the recovery to bolster effective policy making in the area of labour markets and social protection in response to economic crises. With nearly 270 participants from 60 countries, this became the largest South-South Learning Forums supported by the RSR.
- Cash Transfers and Conditional Cash Transfers in Africa – Community of Practitioners (\$450,000) has built a community of practice for cash transfers and conditional cash transfers interventions within selected Sub-Saharan African countries. It started with Tanzania, Kenya, Ghana, Nigeria, Ethiopia, and Niger but now the membership has expanded to 18 countries. About 100 policy makers and practitioners are learning from each other.
- Development of the ADePT Crisis Module (software platform for economic analysis) (\$250,000) supports the development of the software platform for crisis diagnostics and the design of policies for crisis prevention (<http://go.worldbank.org/LYSYKZK9P0> for more information).

56. NGOs are already making a strong contribution to building up the body of evidence on vulnerability and how social protection can function in the Sahel:
- They have analysed the impact of their social protection programmes, for instance the study of Save the Children's social protection pilot in Niger.
 - They have widely disseminated their findings and used them to lobby donor governments, for instance in the Sahel Working Group publication *Escaping the Hunger Cycle: Pathways to Resilience in the Sahel* and Oxfam UK's report *Learning the Lessons: Assessing the response to the 2012 food crisis in the Sahel to build resilience for the future*. These publications and many others synthesise and analyse evidence and provide evidence backed policy recommendations.
 - The multi-agency Household Economy Analysis (HEA) Sahel project is led by Save the Children and covers seven countries. It has made significant progress since 2010 in strengthening regional early warning systems, specifically by integrating analysis of household food access and poverty. The next phase, currently under development, will build on these foundations to improve decision-making for timely, appropriate, well-targeted emergency response, while also expanding the evidence base for longer-term resilience policies.
 - There has been uptake of NGO research by Sahelian governments: the Niger government's social protection programme was designed to build on the lessons and successes between 2005-2009 of CARE International, Save the Children UK and the British Red Cross.

Conclusion: there is strong evidence that donors, NGOs and governments are building the evidence base, sharing knowledge, and using learning on social protection systems.

4. Evidence of the use of social protection in the Sahel region

57. Current government use of and investment in social protection systems

- The current level of institutional coordination of SP policies and implementation capacity vary within the Sahel countries. A few countries have adopted Social Protection Strategy policies and have created coordination institutions that will facilitate the dialogue across several stakeholders. The best examples of these efforts can be found in Burkina, Mali and Niger, which have adopted social protection strategies between 2007 and 2012. However, more effort is now needed to develop action plans to implement actual policies and programs as some those countries are currently trying to do.
- The actual implementation of SP programs is carried out by several institutions and line ministries which are donors influenced and have a stronger focus on relief. As a result the selected institution may not have the expected capacity or the coordinating mandate. In both Burkina Faso and Mali, the key ministries in charge of safety nets do not operate any major anti-poverty transfer programs. In Burkina Faso, even though the MASSN (Ministère de l'Action Sociale et de la Solidarité Nationale) has a strategic focus on social safety nets and social action, it runs no significant social safety net program. The same is true of the MDSSPA (Ministère du Développement Social, de la Solidarité et des Personnes Agées) and the FSN (Fonds de Solidarité Nationale) in Mali. In other countries new units have been created, like the new safety net unit in Niger which has the mandate to implement and help coordinate Safety Net programs.

58. Evidence from NGO studies in the Sahel:

- **In a Save the Children pilot study of cash transfers in Niger** 21% of recipient households started income generating activities such as small-scale trade, and most recipient households chose to stop other forms of low-paid labour in order to invest time in their own fields, leading to a significant increase in food production. Compared with what they would produce in a typical year, beneficiary households produced the equivalent of two more months' worth of millet – i.e. 50% more than they produced beforeⁱⁱⁱ.
- **Concern Worldwide integrated approach in Niger.** Concern has been responding to crises in one of the worst affected areas of Niger since 2005. In 2010 Concern started an integrated programme approach that combined cash transfers with nutrition and health activities to improve the nutritional status and wellbeing of children under the age of five. Over the course of three years Concern conducted operational research that proved that integrated cash, community participation and nutrition actions positively impacted households' wellbeing, with a substantial drop in acute malnutrition^{iv}.
- **Tearfund's integrated approach with pastoralists in Niger:** One specific notable success is a project working with pastoralists in Abalak, Niger (2400 beneficiaries). This program integrates crisis relief and long term resilience building development into a single package. A combination of Cash for Work and Reduced Price sales of grain and the use of the proceeds to reinforce existing grain and animal fodder banks has allowed donors' funds to work three times. The funds are used to provide long term improvements in the land, building resilience and improving food security. The reinforced banks improve resilience and food security in the medium term, and the cash paid and reduced price sales provide immediate relief improving food security and boosting purchasing power in the short term. The project also integrates micro credit which has shown capital increases of 276%. Testimonies from members say that the fund has a significant positive impact on household resilience, allowing them to protect their animal capital and other economic interests from shocks, as well as maintain a higher level of food security in their households^{iv}.

59. Evidence from other West African francophone countries of benefits from the RSR fund:

- In Cameroon a grant of \$550,000 from the RSR, supported an assessment of the feasibility of cash transfers and the design of key operational features for a new programme (targeting, beneficiary registry, payments and M&E). This work has initiated a new social protection programme that will be financed by IDA, with an indicative commitment of \$50m from the Government of Cameroon.
- Togo - Support to Social Safety Net Development (\$220,000) developed a cash transfer programme, improved the design of existing programmes and moved toward a more integrated national system. These outputs catalysed TOGO Community Development and Safety Nets Project, financed with \$14m from IDA. The project was approved in March 2012, and expected to extend the social safety nets to nearly 10,000 new beneficiaries by Year 2, and 18,000 by Year 4.
- Guinea - Strengthening Social Safety Nets in Times of Crises (\$400,000) has been assisting the Government in laying the foundations of a safety net system capable of effectively responding to crises and increasing people's resilience to withstand future shocks. This has led to the approval of Guinea: Productive Social Safety Net Project in June 2012 for \$25m from IDA. The benefit of this project is expected to be felt by more than 50,000 poor and vulnerable people by Year 2.

Conclusion: there is strong evidence that it is possible to implement sub-national social protection programmes in the Sahel. There is medium evidence that social protection programmes can be effective in the Sahel context at improving resilience and attracting further donor funding. There is limited evidence on the scalability, costs and specific impacts of social protection in the Sahel context, which types of social protection interventions are the most effective, and which methodologies for implementing social protection are the most efficient (e.g. different forms of targeting and delivery mechanisms).

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- ⁱ Government of Kenya, June (2012) Kenya Social Protection Sector Review.
- ⁱⁱ DFID (2011). Cash Transfers: Evidence paper. Policy Division, DFID London.
- ⁱⁱⁱ *Ibid.*
- ^{iv} Devereaux S, Cipryk (2009) Social Protection in Sub-Saharan Africa: A Regional Review Institute of Development Studies Prepared as part of a Social Protection Scoping Study funded by the Ford Foundation, op cit, p 24
- Alderman, H., and R. Yemtsov. 2012. "The Productive Role of Social Protection." Background paper to the Social Protection and Labor Strategy, World Bank, Washington, D.C.
- ^{vi} DFID Cash Transfers Literature Review 2011
- ^{vii} Economics of Early Response and Resilience, CHASE, 2012
- ^{viii} The [2011 World Development Report](#) on conflict, highlights how inclusive social protection can address sources of social tension (for example, high youth unemployment or, as in Nepal, pockets of acute poverty amongst ethnic groups traditionally excluded from the state) while expanding access to opportunities and creating the basis for broad-based growth.
- ^{ix} ODI October 2012. Social Protection and Basic Services in Fragile and Conflict Affected Situations. Samuel carpenter, Rachel Slater and Richard Mallet. Secure Livelihoods Research Consortium. Working paper 8
- ^x World Bank. March 2012. Productive Role of Safety Nets. Harold Alderman and Ruslan Yemtsov. Social Protection and Labor Discussion paper No. 1203.
- ^{xi} ODI. March 2013. Holding Cash Transfers to Account. Fiona Samuels and Nicola Jones. transformingcashtransfers.org
- ^{xii} DFID Cash transfers literature review, 2011, p45
- ^{xiii} Holmes, R., 2009. *Cash transfers in post-conflict contexts*, Overseas Development Institute, London.
- ^{xiv} Climate Change Adaptation, Disaster Risk Reduction and Social Protection; Davies, M, Oswald, K and Mitchell, T; (IDS) P201 In Promoting Pro-poor Growth: OECD (2009)
- ^{xv} DFID, (2007) Bangladesh Reducing Extreme Poverty in the riverine areas of North-West Bangladesh: Options for the Chars Livelihoods Programme beyond 2010
- ^{xvi} "Insurance against Losses from Natural Disasters in Developing Countries"; DESA Working Paper No. 8; Joanne Linnerooth-Bayer and Reinhard Mechler; October 2009
- ^{xvii} Cole S, Bastian G, Vyas S, Wendel C, Stein D (2012) The effectiveness of index-based micro-insurance in helping smallholders manage weather-related risks .London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
- ^{xviii} Index-based livestock insurance; protecting pastoralists against mortality due to severe forage scarcity; Mude, A. ILRI Conference on The future of Pastoralism in Africa; March 2011
- ^{xix} Social Protection and Climate Resilience, p17:
http://www.google.co.uk/url?sa=t&rct=j&q=social%20protection%20climate%20change&source=web&cd=15&ved=0CFEQFjAEOAo&url=http%3A%2F%2Fsitesources.worldbank.org%2FEXTSOCIALDEVELOPMENT%2FResources%2F244362-1232059926563%2F5747581-1239131985528%2FWBSocProtec_Final.pdf&ei=YbiUUzB9CI7qOND8gOgN&usg=AFQjCNFz8B8qLpiieiAZbHXA8E9FhUsO1w
- ^{xx} Social Protection and Climate Resilience, p33:
http://www.google.co.uk/url?sa=t&rct=j&q=social%20protection%20climate%20change&source=web&cd=15&ved=0CFEQFjAEOAo&url=http%3A%2F%2Fsitesources.worldbank.org%2FEXTSOCIALDEVELOPMENT%2FResources%2F244362-1232059926563%2F5747581-1239131985528%2FWBSocProtec_Final.pdf&ei=YbiUUzB9CI7qOND8gOgN&usg=AFQjCNFz8B8qLpiieiAZbHXA8E9FhUsO1w
- ^{xxi} World Bank. 2011. Gender and Climate Change: Three Things You Should Know.
- ^{xxii} Agarwal, Bina (2010). *Gender and Green Governance: The Political Economy of Women's Presence Within and Beyond Community Forestry*. Oxford: Oxford University Press.
- D. Layne Coppock, Solomon Desta, Seyoum Tezera, Getachew Gebru 2011. Capacity Building Helps Pastoral Women Transform Impoverished Communities in Ethiopia. Science. DOI: 10.1126/science.1211232
- ^{xxiv} Kenya HSHP, Monitoring and Evaluation Component, Impact Analysis Synthesis Report, Oxford Policy Management (OPM) and Institute of Development Studies (IDS) (May 2012). This impact evaluation of HSNP was conducted using a mixed methods approach. A randomised control trial was designed, with fieldwork in 24 'treatment' and 24 'control' sub-locations, randomly selected. A sample of 1,434 treatment and 1,433 control households.
- ^{xxv} A robust measure of programme impact after one year is provided by the four year one impact reports Kenya Hunger Safety Net Programme Monitoring and Evaluation Component Impact Analysis Synthesis Report, May 2012; Kenya Hunger Safety Net Programme Monitoring and Evaluation Component Quantitative Impact Evaluation Report: 2009/10 to 2010/11, May 2012; Kenya Hunger Safety Net Programme Monitoring and Evaluation Component Qualitative Impact Evaluation Report: 2009/10 to 2010/11, March 2012; Kenya Hunger Safety Net Programme Monitoring and Evaluation Component Consolidated Operational Monitoring Report, May

2012. OPM (2012a), Consolidated Operational Monitoring Report, Kenya Hunger Safety Net Programme: Monitoring and Evaluation Component; OPM and IDS (2012b), Qualitative Impact Evaluation Report: 2009/10 to 2010/11, Kenya Hunger Safety Net Programme: Monitoring and Evaluation Component, Oxford Policy Management (OPM), Oxford and Institute of Development Studies (IDS), Brighton
- OPM and IDS (2012b), "Quantitative Impact Evaluation Report: 2009/10 to 2010/11, Kenya Hunger Safety Net Programme: Monitoring and Evaluation Component," Oxford Policy Management (OPM), Oxford and Institute of Development Studies (IDS), Brighton.
- xxvi OPM (2011). A Preliminary Evaluation of the Impacts from the Hunger Safety Net Programme, Kenya and OPM (2012a), "Consolidated Operational Monitoring Report, Kenya Hunger Safety Net Programme: Monitoring and Evaluation Component," Oxford Policy Management (OPM), Oxford
- xxvii NAO (2011). Transferring Cash and Assets to the Poor.
- xxviii Hodges A., White P. and Greenslade M. (2011). Guidance for DFID Country Offices on Measuring and Maximising Value for Money in Cash Transfer Programmes. DFID, London.
- xxix DFID (2011). Cash Transfers, Evidence Paper. Policy Division. DFID, London.
- xxx *Ibid.*
- xxxi *Ibid.* There is growing evidence that transfers can help people escape *chronic, often inter-generational poverty*; in part by leveraging gains in non-income, human development outcomes, accelerating progress towards Millennium Development Goal (MDG) targets. Finally, there is recognition that in situations of chronic food insecurity (e.g. Ethiopia), institutionalised transfer programmes are more efficient and effective than repeated annual emergency food aid.
- xxxii GoK (2012) Kenya Social Protection Sector Review. June 2012
- xxxiii PRRO is focused on the ASALs and consists of 3 programmes: (i) General Food Distribution (GFD) (2,180,858 beneficiaries in 2010); (ii) Supplementary Feeding for child nutrition (454,677 beneficiaries in 2010); and (iii) Food for Assets (140,000 beneficiaries in 2010). It has the following objectives: 1) Assist emergency-affected households in reducing the impacts of shocks by addressing their food needs; 2) Reduce acute malnutrition among children under 5 and pregnant and lactating women in identified populations in crisis-affected areas; 3) Enhance communities' resilience to shocks through asset creation, and increase government capacity to design and manage disaster-preparedness and risk; 4) Support and re-establish livelihoods, food security and nutrition aftershocks.
- xxxiv *Ibid.*
- xxxv GoK (2012) Kenya Social Protection Sector Review. June 2012
- xxxvi World Bank (2012). The World Bank's Africa Social Protection Strategy 2012–2022.
- xxxvii DFID (2012) Ethiopia's Productive Safety Net Programme, 2010-2014 – a value for money assessment.
- xxxviii World Bank (2013) The Kenya National Safety Net Program for Results Technical Assessment. (14.1.13)
- xxxix World Bank (2012). The World Bank's Africa Social Protection Strategy 2012–2022. DFID (2012) Ethiopia's Productive Safety Net Programme, 2010-2014 – a value for money assessment and PSNP transfer review study.
- xl McCord A and Slater, R. (2009) Overview of Public Works Programmes in Sub-Saharan Africa. ODI Report to World Bank.
- xli In "Social Protection and Climate Resilience"; Report of International Workshop; Addis Ababa; 2011
- xlii Draft DFID programme performance report for PNSP Ethiopia, based on the mid-2012 data
- xliii A Vision for the Future of Technical Assistance in the International Development System, Oxford Policy Management 2003
- xliv Draft ROACH methodology: http://www.um.dk/NR/ronlyres/248E3D29-DA6E-4448-976E-B9134369CB72/0/CDEstep3_Methodology.pdf
- xlvi Improving Technical Assistance in the context of SWAps Javier Martínez, HLSP, July 2006
- xlvi DFID TA How To Note, 2006
- xlvi See: <http://www.gsdr.org/docs/open/HDQ850.pdf>
- xlviii IEG (Independent Evaluation Group). 2011. Social Safety Nets: An Evaluation of World Bank Support, 2000–2010. Washington, DC: Independent Evaluation Group, the World Bank Group.
- xlix Golooba (2012)
- l DFID Pakistan (2012) Business Case for Pakistan National Cash Transfer Programme: Reducing Poverty, Getting Poor Children into School
- li Ernst and Young (2011); Ward *et al.* (2010)
- liiii GHK (2009); Calder *et al.* (2011)
- liii Save the Children UK, 'How cash transfers can improve the nutrition of the poorest children: evaluation of a pilot safety net project in Southern Niger', 2009. Although the cash transfers were unconditional, beneficiaries were required to take part in awareness sessions on malnutrition
- liv Information given through Sahel Working Group
- lv Information given through Sahel Working Group

Assessing the Strength of Evidence

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Introduction

Why does the strength of evidence matter?

1. Strong evidence is of central importance in informing policy and programming decisions across UK government departments. Robust research and evaluation generates the evidence required to form judgements, deliberate options and make intelligent decisions about how to spend scarce financial resources on behalf of taxpayers. It is critical to the work of all DFID staff and Ministers, and especially for the presentation of appraisal options in Business Cases.¹ It is vital that research evidence is evaluated in a fair and balanced way.

What is the purpose of this guidance note?

2. This Note provides a thorough introduction to:
 - a. the appraisal of the quality of **individual studies**;
 - b. the assessment of the strength of **bodies of evidence**.
3. The Note is an integral part of DFID's commitment to equipping staff with the skills and specialist advice to help them improve their use of evidence. Other resources include:
 - a. A Guide to Research Designs & Methods;²
 - b. The Evaluation Handbook, providing guidance on evaluation designs and methods;³
 - c. 'Using statistics' How to Note;⁴
 - d. A set of guidance materials about how to summarise research evidence.⁵
4. Assessing the strength of evidence is a challenging task. This Note sets a high standard for DFID staff. It requires a combination of technical knowledge and individual judgement. It may also require consultation with research specialists within and outside DFID. Proper assessment of evidence will help staff use evidence responsibly and judiciously for the benefit of better policy and programmes. Specifically, this Note will:

¹ See, for example, <http://www.bis.gov.uk/go-science/science-in-government/strategy-and-guidance>

² See the '[Research Methods](#)' guide pages on InSight.

³ See Evaluation Department's Handbook, ch. 4, '[Choosing your evaluation approach \(design and methodology\)](#)'.

⁴ Global Statistics Partnerships Team, 'Using Statistics' How to Note, forthcoming.

⁵ See the *Evidence Synthesis Sourcebook*, available from DFID's Evidence into Action Team. Contact: w-evans@dfid.gov.uk.

- a. help staff to broadly understand the distinctions between different data collection and analytical methods and what they can and cannot conclude as a result;
 - b. establish a common language that can be used in the discussion of the strength of evidence.⁶
5. This guidance is applicable to all categories of research and evaluation evidence used by DFID staff, especially in the social sciences. It applies to evidence generated through both quantitative and qualitative research methods.⁷ It recognises that some academic disciplines, such as medicine, and the methodologies associated with them, have a stronger tradition of assessing quality of research than social science disciplines.⁸ The Note references alternative evidence grading frameworks accordingly. To ensure consistency, this Note also draws on approaches developed in other parts of Government to assess research and evaluation evidence.⁹
 6. A summary of this Note is incorporated into the revised [Business Case guidance](#) for ease of reference.

A note on terminology

7. Note that the terms ‘quality’, ‘size’, ‘context’, ‘consistency’ and ‘strength’ of evidence should be used with care in accordance with the definitions in this How to Note. This Note assumes that the overall ‘strength’ of a body of evidence is determined by the quality, size, context and consistency of the body of evidence.

⁶ The Note will be reviewed after one year based on feedback from staff and academic experts.

⁷ The Economic and Social Research Council includes the following disciplines as social science research: economics, psychology, political science, sociology, anthropology, geography, education, management and business studies though some subject areas (such as livelihoods) cut across the social and natural sciences.

⁸ Standards of evidence are most developed in the health field. For health, the Cochrane Collaboration and Campbell Collaboration have established clear metrics for assessing research evidence and the conduct of systematic reviews. There is also a high degree of consensus on the basis for determining the quality of research evidence in the economics field. See <http://www.thecochranelibrary.com>; <http://www.campbellcollaboration.org/library>; GSDRC Helpdesk Research Report, *Qualitative Evaluation and Research*, 24 March 2012.

⁹ Examples include Spencer, L., et al., 2003, *Quality in Qualitative Evaluation: A Framework for Assessing Research Evidence*, National Centre for Social Research, Cabinet Office, London. http://www.civilservice.gov.uk/wp-content/uploads/2011/09/Quality-in-qualitative-evaluation_tcm6-38739.pdf. Also see Government Social Research Service on Rapid Evidence Assessments, <http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance/rapid-evidence-assessment/how-to-do-a-rea>

How should staff apply this guidance note to their work?

8. The current Note has been endorsed by the DFID Research Committee. As such, it is expected that DFID staff will apply the Note to their work as follows:

DFID Evidence Products:

9. DFID produces or commissions the following evidence products. It does so in conjunction with its partners and the Professional Evidence and Applied Knowledge Services (PEAKS) facility:
 - a. Systematic Reviews: produced externally
 - b. Evidence Papers: produced internally by DFID
 - c. Literature Reviews: may be produced internally **or** externally
 - d. Rapid Reviews: may be produced internally **or** externally
 - e. Annotated Bibliographies: typically produced externally
 - f. Evidence Maps: typically produced externally

The current Note should be applied to these products as follows:

- g. Parts I, II and III (see Contents, above) **must be** applied to the discussion and citation of evidence in the 'Evidence Paper' category of evidence products;
- h. It is **highly desirable** for Literature Review evidence products to draw on Parts I, II and III;
- i. This Note is to be issued **as a guide** prior to the production of all evidence products. It serves as an indication for DFID's aspirations for all discussions of evidence. Its formal application to Rapid Reviews, Annotated Bibliographies and Evidence Maps and other knowledge services products is discretionary.

Business Cases:

- j. Business Cases, Ministerial submissions and policy papers should draw on Part IV (see Contents, above) of the guidance. They will preferably draw upon evidence synthesis products that have themselves been written with reference to Parts I, II and III.

Alternative sources

10. Where professional advisory cadres feel that the current Note does not fully serve their needs, they may wish to draw on established mechanisms in particular disciplines for assessing the strength of evidence. However, where they do so, they should ensure that the same aspects of evidential strength covered in this Note feature in their analysis.
11. Other sources of information for grading single studies and evaluating bodies of research include the following:

- a. The [Research Excellence Framework \(REF\) 2014 assessment methodology](#);
 - b. The [GRADE](#) approach to assessing quality of health research studies;
 - c. The [NICE Guideline Development Methods](#) on assessing quality of health research studies;
 - d. [Critical Appraisal Skills Programme](#): multiple checklists for assessing the application of particular research designs and methods, the quality of single studies and bodies of evidence;
 - e. Civil Service '[Rapid Evidence Assessment](#)' framework from the HMG Government Social Research Unit which provides guidance relating to assessment of bodies of evidence;
 - f. DFID Insight Evidence & Resources pages, containing [guidance on critical appraisal](#);
 - g. Louise Shaxson's [evidence assessment template for policy-makers](#).
12. This HTN is accompanied by a short summary, which serves as a reminder of the main sections of the full Note.

Part I: Describing a single study

13. The current note recommends that single studies be described and categorised as follows:
- a. by type
 - b. by design
 - c. by method.
14. The following sections of this note explain how.

Type of research

15. This note recommends the categorisation of research studies by overarching type as follows:
- a. *Primary, empirical research studies* observe a phenomenon at first hand, collecting, analysing or presenting 'raw' data.
 - b. *Secondary research studies* review other studies, summarising and interrogating their data and findings.
 - c. *Theoretical or conceptual studies*, like secondary research studies, draw on previous research, but they do so primarily to construct new theories rather than generate, or synthesise empirical 'evidence'.

Research Designs, Research Methods

Introduction

16. A research design is a framework in which a research study is undertaken. It employs one or more research methods to:
 - a. collect data
 - b. analyse data.
17. Collected data can be either quantitative (data aggregated by numbers) or qualitative in nature.
18. Data analysis methods can also be quantitative (using numbers to illustrate data or demonstrate causal relationships) or qualitative (collating 'rich' data and inferring its meaning).
19. Increasingly, the line between quantitative and qualitative research is being blurred by the successful development of mixed method studies. Mixed methods may involve the quantitative analysis of qualitative data or the interrogation of quantitative data through a qualitative lens.¹⁰
20. Many research designs aim in some way to explore causal relationships. Some designs are better suited for *demonstrating* the presence of a causal relationship, whilst others are more appropriate for *explaining* such causal relationships. Different designs are also more or less suited to exploring the wider applicability of the research findings to a variety of contexts.
21. **Primary & empirical** research studies tend to employ one of the following research designs, but as noted above, they may employ more than one research method.
 - a. *Experimental* research designs (also called 'intervention designs' and 'randomized designs') administer a 'treatment' or 'intervention' to a 'treatment group', but not to a 'control group.' In such designs, the researcher deliberately manipulates the intervention (or 'independent variable') in order to explore its effects on the subject group. Crucially, experimental designs allocate subjects (people, animals, villages etc.) to 'treatment' or 'intervention' groups *at random*. This increases the chances that any difference in effect observed is a direct result of the treatment administered. Experimental research designs subject data exploring the subsequent behaviour of the two groups to quantitative analysis (specifically 'descriptive statistics' followed by 'inferential statistics'). The combination of random assignment and quantitative analysis enables the construction of a robust 'counter-factual' argument (i.e. "what would have happened in the absence of the intervention or treatment?"). Such designs are useful for

¹⁰ Stern, E. and others (2012). "Broadening the Range of Designs and Methods for Impact Evaluations." Department for International Development, Working Paper 38, p. 30.

demonstrating the presence, and size of causal linkages (e.g. “*a* causes *b*”) with a high degree of confidence. Randomised Control Trials (RCTs) are a well-established form of experimental research.

- b. *Observational* (sometimes called ‘non-experimental’) research designs may be concerned with the study of groups that have received a ‘treatment’ with comparison groups that have not. However, unlike experimental research designs, it is not the researcher who deliberately manipulates the intervention: s/he is merely an ‘observer’ of a particular action, activity or phenomena (hence the name ‘observational’). Some ‘analytical’ observational studies use advanced quantitative analysis (specifically ‘inferential statistics’) to infer causal relationships between phenomena. Others are more descriptive in nature, and may be more appropriate for teasing out explanations for causal relationships. The following are examples of observational research methods:
 - i. Observational-analytical: Cohort and/or longitudinal designs; case control designs; cross-sectional designs (supplemented by quantitative data analysis); large-n surveys.
 - ii. Observational-descriptive: Interviews, focus groups, case studies, historical analysis, ethnographies, political economy analysis.¹¹

The risks of ‘selection bias’ and ‘confounding bias’

A principal advantage of experimental designs (notably RCTs) over observational (also called ‘non-experimental’ designs) is that they reduce the risks of ‘selection bias’ and ‘confounding bias’. ‘Selection bias’ is the risk that the population receiving a treatment or intervention is somehow dissimilar to the ‘control’ group (a flaw which could invalidate a study). ‘Confounding bias’ is the risk that there is an additional, ‘unseen’ variable which is causing a particular effect. The ‘randomisation’ aspect of RCTs mitigates effectively for both of these risks, allowing the construction of a robust ‘counter-factual’ argument.

In some cases, specific sampling methods and ‘fixes’ can be applied to observational studies. Subjects are not assigned randomly to treatment or control groups, but patterns in the characteristics of the population are used by the researcher to control (partly) for selection bias and confounding bias. In such cases, studies are sometimes called ‘**Quasi-Experimental**’ designs. Regression discontinuity design is an example of a quasi-experimental design.

22. The current Note avoids constructing a hierarchy of research designs and methods (though some disciplines do consider designs and methods hierarchically).¹² It recognises that different designs are more or less appropriate to different contexts, and different

¹¹ Stern, E. et al. (2012). “Broadening the Range of Designs and Methods for Impact Evaluations.” Department for International Development, Working Paper 38.

¹² See for example, ‘Levels of Evidence’ [diagram](#), Evidence-Based Practice in the Health Sciences, Evidence Based Nursing Tutorial.

research questions.¹³ Counterfactuals are likely to be important for establishing the presence and strength of a causal relationship, but explanation for the nature of, and mechanisms behind causal relationships is often best achieved by observational designs using qualitative methods. Experimental and observational designs (both analytical and descriptive, quantitative and qualitative) can be used effectively together, with a range of methods either 'mixed' together. Typically, stronger bodies of evidence are likely to be characterised by the availability of a wide spectrum of evidence which uses, and triangulates several research designs and methods.

23. **Secondary studies** tend to employ one of the following research designs:

- a. *Systematic Review* designs adopt systematic methods to searching for literature on a given topic. They interrogate multiple databases and search bibliographies for references. They screen the studies identified for relevance, appraise for quality (on the basis of the research design and methods they employ), and synthesise the findings using formal quantitative or qualitative methods. Systematic Reviews are always clearly labelled as such.¹⁴ They represent a robust, high quality technique for evidence synthesis. Some caution should nevertheless be exercised in using the findings of Systematic Reviews: they must show that they are comparing 'like with like' studies. In addition, Systematic Reviews may suffer from issues relating to external validity (or 'generalisability' – see para 34 below for an explanation).
- a. *Non-Systematic Review* designs also summarise or synthesise literature on a given topic. Some non-systematic reviews will borrow some systematic techniques for searching for and appraising research studies and will generate rigorous findings, but many will not.
- b. *Theoretical or conceptual* research studies may adopt structured designs and methods, but do not generate empirical evidence. Theoretical or conceptual research may be useful in designing policy or programmes and in interrogating underlying assumptions and empirical studies, but should not be referred to as 'evidence'.

Why categorise studies by type, design & method?

24. The different types of study, different designs and methods outlined above are more or less appropriate for answering different types of research question. Categorising studies by type provides the reader with an initial, general understanding of how the study's

¹³ Stern, E. et al. (2012), p. 2. For a helpful overview of the different sorts of questions which are best answered by different research designs and methods, see Petticrew, M. & H. Roberts (2003), "Evidence, hierarchies and typologies: horses for courses." *Journal of Epidemiology and Community Health*, 57: 527-529, and Sandbrook, C. (2013), "Biodiversity, Ecosystem Services and Poverty Alleviation: What constitutes good evidence? A discussion paper." The Poverty and Conservation Learning Group Discussion Paper No. 10.

¹⁴<http://dfidinsight/Other/Departments/EvidenceResources/Synthesizedevidenceproducts/Systematicreviews/index.htm>

findings were arrived at, and helps the reader begin to make some general judgements about the credibility of the study.

25. This Note recommends the use of the following descriptors to describe single research studies by type:

| Research Type | Research Design |
|--------------------------------|---|
| Primary & Empirical (P&E) | Experimental (EXP) + state method used |
| | Observational (OBS) + state method used |
| Secondary (S) | Systematic Review (SR) |
| | Other Review (OR) |
| Theoretical or Conceptual (TC) | N/A |

How it looks in practice

26. In practice, synthesising evidence using this convention would result in summaries of single studies as follows:

- a. For example, when citing a primary and empirical study by Jones, who uses an experimental research design, the citation may be written as (Jones, 2005 [P&E; EXP]).
- b. In the case of an observational case study by Smith, the citation may be written as (Smith, 2004 [P&E; OBS, case study]).
- c. In the case of a secondary study by Vaughan, where it is clear that a formal systematic review design was employed, the citation may be written as (Vaughan, 2008 [SR]).

27. This Note strongly recommends that the method (not just the design) on which a single study is based should also be noted when it is cited.

Part II: Assessing the quality of single studies

28. Following the description of a single study by type, design and method the reviewer or user should aim to consider its quality. Although this is not a trivial exercise, there are some general rules of thumb that all advisers will be able to apply. Staff may wish to consult colleagues who have particular expertise in a certain discipline, or Senior Research Fellows when faced with a particularly challenging technical study.

A note on assessment of secondary research studies
 Note that assessment of study quality using these rules of thumb is possible for primary and empirical studies only. Systematic Reviews (when published officially as such) can be assumed to be of a high quality. The assessment of the quality of other, non-systematic reviews is a matter of judgement.

29. The reviewer is looking principally to assess the quality of the study *in its own right* and its appropriateness for answering the research question posed by the author of the study. An assessment of the *relevance* or applicability of the study to a specific policy question or business case is an important, but separate, part of evidence synthesis, which is covered later in this How to Note.

Proxies for quality: journal rankings and citation frequency

30. Rankings and rating systems applying to both journals and individual academics can provide a useful proxy guide to the quality of a research study although the validity of such rankings for such purposes is subject to considerable debate. Journal rankings provide an indication of the standard of peer review to which a publication has been subjected, or information on the frequency with which a study or academic has been cited.¹⁵ The status of publications, in terms of the 'impact factor' of peer reviewed journals, can therefore inform an assessment of quality. DFID staff should treat academic peer-review as an important mechanism.

31. However, not all well-designed and robustly applied research is to be found in peer reviewed journals and not all studies in peer-reviewed journals are of high quality. Journal rankings do not always include publications from southern academic organisations or in online journals, so a broad and inclusive approach is required to capture all relevant studies.

Principles of high quality studies

32. Whilst this Note acknowledges the diversity of methodological approaches of multiple academic disciplines, it outlines principles of credible research enquiry that are common to all. It also recognises that an assessment of the quality of a study should involve consideration of the relationship between the researcher and the subjects being studied and that appropriate ethical guidelines have been followed.¹⁶

33. The first principle is a *desirable* feature of high quality studies:

- a. **Conceptual framing:** High quality studies acknowledge existing research or theory, and make clear how the current/new analysis sits within the context of existing work. They typically construct a conceptual or theoretical framework, which shows how a researcher thinks about an issue, and lays bare their major assumptions. High quality studies pose specific research questions or hypotheses to which the research seeks to respond.

¹⁵ See, for example, the Thomson Reuters impact factor ratings for 'Planning and Development Studies': http://thomsonreuters.com/products_services/science/academic; Thomson Reuters *Essential Science Indicators*, and Thomson Reuters *Highly Cited* index: <http://www.highlycited.com/>

¹⁶ See, for example, International Institute for Environment and Development (2012), *Towards Excellence: Policy and Action Research for Sustainable Development*, London: IIED.

34. The following principles are features *required* for a study to be considered of a high quality. They may be covered explicitly or implicitly by the author of a single study:

a. **Openness and transparency:** High quality studies should be transparent about the design and methods that have been employed, and the data that has been gathered and analysed. This allows for the study results to be reproduced by other researchers, or modified with alternative formulations. As such, failure to disclose the data and code on which analysis is based raises major questions over the credibility of the research. An important sign of quality is whether the author is being self-critical and open about limitations and alternative interpretations. Pointing out inconsistencies with other results helps put the study in its proper context. There is also the question of independence: a study paid for and/or conducted by an aid agency might be perceived as less independent than a study conducted by a third party: ideally, a high quality study will be explicit about how it was funded.

b. **Appropriateness and rigour:**

What it means: This refers to the appropriateness of the design and methods to the research question and its rigorous application. There are two main types of (see above), and many types of methods. None is necessarily 'better' or 'worse', but some designs and methods are certainly more appropriate for use in specific settings or for responding to particular types of research question than others.

Typically, experimental research designs tend to be more appropriate for identifying, with confidence, the presence of causal linkages between observable phenomena. However, if the methods are improperly applied, it is possible for experimental studies to be of a low quality. The diverse array of observational (or 'non-experimental' designs) may be more appropriate for contexts and phenomena which cannot easily be explored through experimental designs, such as exploring the mechanisms behind a causal linkage, or for deepening understanding of people and behaviours that lie at the heart of most development processes.¹⁷ Crucially, using an inappropriate method to tackle a question in a particular context is unlikely to yield credible or useful results.

How to assess appropriateness and rigour: The reader of the single study should try to identify the specific question that the paper's author is trying to address. Is it about identifying causation? Is it about quantification of a trend, or about the meaning and implications of a trend? Is the research based on developing a conceptual model and then confronting that model with the data? Answering such queries is a good starting point in determining whether or not the research design and methods employed were appropriate for the study question and the context.

¹⁷ See in particular Stern, E. and others (2012), "Broadening the Range of Designs and Methods for Impact Evaluations." Department for International Development, Working Paper 38, pp. 18, 24.

c. **Validity:**

What it means: There are several types of scientific validity. Three of the most important are covered here.

Measurement Validity: During the data collection phase of a study, a researcher may set out to measure or interrogate a particular concept. S/he typically selects a particular indicator to do so (e.g. metres as an indicator to measure distance). 'Measurement validity' describes whether or not the indicator is well suited to measure the concept in question. For example, if a study wants to measure individual welfare, it has to choose a valid indicator of 'welfare'. Family income, individual health, or individual happiness might be valid indicators, but, in contrast, the value of national exports would be much less satisfactory.

Internal Validity: Some studies (typically experimental and quasi-experimental designs) seek to demonstrate that the emergence of one factor is attributable to (i.e. causing) another. For example, a study may show that rich people tend to live in expensive neighbourhoods. But are they rich because they live in a wealthy neighbourhood, or is the causal relationship working the other way round? Assessing the 'internal validity' of a study means evaluating whether or not the technique that the study uses to explore such causal chains is satisfactory. If the design doesn't take account of 'unseen' (sometimes called 'confounding') factors that might be causing a particular phenomenon, then the study may over- or under-estimate the importance of a particular issue as a cause of an observed outcome or behaviour.

External Validity: This describes the extent to which the findings of a study are likely to be replicable across multiple contexts: can they be generalised?

How to assess validity: In the case of measurement validity, it is important to repeatedly consider whether or not the indicator chosen fully captures the concept being measured. Are there other dimensions of the central concept that are being ignored? In the more complex case of internal validity, a starting point is to try to think of other possible causal mechanisms that the researcher has not acknowledged. In the case of external validity, the reviewer needs to consider whether the case or context being studied is highly particular, or is 'generalisable' to multiple settings.

d. **Reliability:**

What it means: Reliability usually means one of two things. First, the reliability of a measurement means that not only is the right 'thing' being measured but also that it is being measured consistently and accurately. Second, the reliability of an analytical technique means that during the processing or use of data, the analysis is likely to produce consistent results when repeated multiple times.

An unreliable measurement instrument could potentially undermine an entire study. 'Birth weight' might be the right thing to measure in a piece of research, but if not measured accurately, the study is flawed. The reliability of an analytical technique boosts the robustness of a study. If a different result was produced every time the same data was processed with the same technique, the study would not be reliable.

How to assess reliability: Consider the instrument or indicator being used for measuring the concept. Some indicators (like corruption 'scores' based on 'expert judgement') may be particularly prone to unreliability or bias. When assessing the reliability of analytical techniques, consider how any weaknesses in the technique might bias the findings of a study, or mean that different results could be produced.

e. **Cogency:**

What it means: A high quality study will provide a clear, logical argumentative thread that runs through the entire paper. This will link the conceptual (theoretical) framework to the data and analysis, and, in turn, to the conclusions. High quality studies will avoid making claims in their conclusions that are not clearly backed up by the data and findings.

How to assess cogency: If the principles of good reporting have been followed, the author of a high quality study should 'signpost' the reader through the various sections of the study. Try to consider whether or not you would have written the same conclusion or executive summary for the study based on the analysis and results it presents.

35. A really rigorous review of the evidence on a given topic should give due consideration to each of these aspects of study quality. It is possible to construct checklists, or scorecards to grade evidence. Even when formal scoring mechanisms are not used, reviewers of single studies are advised to keep a record of their observations on the following aspects of a study to demonstrate the basis of their assessment and so it can be shared with other members of staff.

| Principles of quality | Associated principles | YES/NO |
|-----------------------------------|---|--------|
| Conceptual framing | Does the study acknowledge existing research? | |
| | Does the study construct a conceptual framework? | |
| | Does the study pose a research question? | |
| | Does the study outline a hypothesis? | |
| Openness and transparency | Does the study present or link to the raw data it analyses? | |
| | Does the author recognise limitations/weaknesses in their work? | |
| Appropriateness and rigour | Does the study identify a research design? | |
| | Does the study identify a research method? | |
| | Does the study demonstrate why the chosen design and method are good ways to explore the research question? | |
| Validity | Has the study demonstrated measurement validity? | |
| | Is the study internally valid? | |
| | Is the study externally valid? | |
| Reliability | Has the study demonstrated measurement reliability? | |
| | Has the study demonstrated that its selected analytical technique is reliable? | |
| Cogency | Does the author 'signpost' the reader throughout? | |
| | Are the conclusions clearly based on the study's results? | |

36. The following descriptors should be used when assessing the quality of single research studies. Directional arrows may be used to signify quality in DFID Evidence Papers and Literature Reviews. Assignment of a particular 'grade' to a study is a matter of judgement for the reviewer. It should be based on consideration of each of the criteria outlined above to ensure consistency of approach across studies.

| Study quality | Abbreviation | Definition |
|---------------|--------------|--|
| High | ↑ | Demonstrates adherence to principles of appropriateness/rigour, validity and reliability; likely to demonstrate principles of conceptual framing, openness/transparency and cogency |
| Moderate | → | Some deficiencies in appropriateness/rigour, validity and/or reliability, or difficulty in determining these; may or may not demonstrate principles of conceptual framing, openness/transparency and cogency |
| Low | ↓ | Major and/or numerous deficiencies in appropriateness/rigour, validity and reliability; may/may not demonstrate principles of conceptual framing, openness/ transparency and cogency |

How it is used in practice

37. To summarise quality of evidence succinctly, reviewers may wish to abbreviate their quality assessment by use of an arrow (see above). However, if they do so, they must be prepared to defend their assessment based on the quality criteria spelled out.
38. Returning to the previous examples, if a user of evidence cites a primary and empirical study by Jones, who uses an experimental method, but the paper is of only moderate quality, the citation may be written as: (Jones, 2005 [P&E; EXP; →]).
39. In the case of a high quality observational study by Smith, the citation may be written as: (Smith, 2004 [P&E; OBS; ↑]). In this case, it is important to be explicit about the method (not just the design) that has been employed.
40. Those citing evidence should not confuse studies which present “evidence of no effect” (i.e. they actually show that ‘x’ has no effect on ‘y’) and those which “find no evidence for an effect” (which means that there may be an effect of ‘x’ on ‘y’, but it hasn’t yet been identified).
41. Assessment of the quality of single studies should appear when cited in Evidence Papers. It is also good practice to follow this convention when drafting or commissioning other evidence products, and in Business Cases, provided that single studies have been subjected to critical appraisal. The assessment of the quality of single studies is a constituent part of summarising the overall value of a *body of evidence* which is commonly used in DFID Business Cases.

Part III: Summarising the main characteristics of a body of evidence

42. Bodies of evidence should be summarised in terms of four characteristics:
- a. The (technical) **quality** of the studies constituting the body of evidence;
 - b. The **size** of the body of evidence;
 - c. The **context** in which the evidence is set;
 - d. The **consistency** of the findings produced by studies constituting the body of evidence.
43. This section of the How to Note is intended to help DFID staff form judgements about the strength of evidence when identifying, sifting and assessing studies for use in Business Cases and policy papers.

Quality of the studies constituting the body of evidence

44. The quality of a body of evidence is determined by the quality of the single studies that constitute it (see Part II, above). Remember, the technical *quality* of the body of evidence is just one discrete component of the overall credibility or strength of a body of evidence (discussed in Part IV, below). For example, it is possible for a body of evidence to be small in size, but high in quality.
45. A summary of the technical quality of the body of evidence should build directly upon prior assessment of the quality of single research studies conducted individually or as part of a secondary study such as a systematic review. When summarising the quality of a body of evidence, similar language should be deployed as is the case when assessing the quality of single research studies, but without needing to use directional arrows:

| Quality of the body of evidence | Definition |
|---------------------------------|---|
| High | Many/the large majority of single studies reviewed have been assessed as being of a high quality, demonstrating adherence to the principles of rigour, validity and reliability. |
| Moderate | Of the single studies reviewed, approximately equal numbers are of a high, moderate and low quality, as assessed according to the principles of rigour, validity and reliability. |
| Low | Many/the large majority of single studies reviewed have been assessed as being of low quality, showing significant deficiencies in adherence to the principles of rigour, validity and reliability. |

Size of the body of evidence

- 46. Across academic disciplines, there is no “magic number” of studies that, when exceeded, denotes that a sufficient or adequate amount of research has been conducted on a particular topic. Nevertheless, empirical findings can be strengthened through repetition and corroboration, in the same contexts and environments, or in different ones. As such, the presence of one study in isolation, uncorroborated by other findings, is unlikely to constitute a large body of evidence.
- 47. The size of a body of evidence is also likely to depend on the research question, research context and subject area. When considering multiple dimensions of a major topic (take malaria as an example) it is useful to record which aspects of that topic (e.g. symptoms and diagnosis; prevention through drugs; prevention by other means; treatment; eradication) have received greater attention in the literature than others. This gives a sense of the *relative* size of the body of evidence in a discrete field.
- 48. Given the absence of a ‘magic number’ of studies to denote ‘adequacy’, it is for the reviewer to decide which of the following terms best describes the size of body of evidence. When doing so, it is good practice to list the number of studies that have been identified.

| Size of body of evidence |
|------------------------------------|
| Large (+ state number of studies) |
| Medium (+ state number of studies) |
| Small (+ state number of studies) |

Context of the body of evidence

- 49. The reviewers of a body of research should also make some note of the origins and context of the evidence that they are quoting. This is closely related to the issue of external validity (see above), and is particularly important given that in many development sciences and programmatic interventions, the findings of research may be context-specific.
- 50. When determining the applicability of evidence from one context to another, the reviewer or policy-maker must take note of the consistency of the results of research, any significant variations in the range of results, and the number of comparable contexts from which evidence has been generated. For example, it is possible for there to be a ‘large’ body of evidence demonstrating the positive effect of a particular intervention, all of which is generated in just two or three countries. Likewise it is possible for there to be evidence sourced from *many* countries but *not* in the country of greatest interest to a DFID programme designer or policy-maker. Ideally, there will be a convincing body of evidence on the likely efficacy of an intervention *both* globally *and* in the context of particular interest.
- 51. The descriptors of the size of the body of evidence are as follows:

| Context |
|------------------|
| Global |
| Context Specific |

Consistency of the findings of studies constituting a body of evidence

52. Such is the complexity of social phenomena that it is possible to have a large body of evidence drawn from multiple contexts, but which nevertheless offers inconsistent findings. In short, the evidence points ‘both ways’.
53. Synthesising multiple studies according to their quality is likely (though not certain) to generate findings that are more consistent. Consistency in a body of evidence reduces uncertainty.
54. The descriptors of the consistency of the body of evidence are as follows:

| Consistency | Definition |
|----------------------|---|
| Consistent | A range of studies point to identical, or similar conclusions |
| Inconsistent (mixed) | Different studies point to a range of conclusions. In some cases, one study will directly refute or contest the findings of another. In other cases, different designs or methods applied in different contexts may simply have produced results that contrast with those of another study. |

Recap: summarising the main characteristics of a body of evidence

55. When summarising or synthesising evidence reviewers should seek to make a comment on the quality, size, context and consistency of a body of evidence but may not be able to assess large numbers of individual studies. Instead, s/he might use the following types of conventions:
- a. “There is a large (+ indicate number of studies) body of global, high quality evidence relating to the efficacy of direct budget support in poverty reduction. The evidence consistently suggests significant positive effects.”
 - b. **Or** “There is a medium-sized (+ no. of studies) body of moderate quality evidence relating to the poverty reduction effects of empowerment and accountability initiatives. The evidence relates directly to country X. However, the findings of the evidence are inconsistent (mixed).”
 - c. **Or** “There is a small-sized (+ no. of studies) and consistent body of evidence that suggests the spread of Information and Communications Technologies (ICTs) is generating greater pressure for increased transparency in government. However, the evidence is of generally low quality.

Part IV: Evaluating the overall strength of a body of evidence

56. The following section presents a framework for assessing the strength of a body of evidence. Both the assessment framework for single studies, and for bodies of evidence could be converted into a numerical calculator, though such an approach is not taken here.
57. Assessment of the overall strength of a *body* of evidence with reference to a particular policy or business case is directly linked to the quality, size, consistency and context of the body of evidence. Where staff are not able to assess all the individual studies that constitute a body of evidence due to inadequate time or expertise, they should (a) seek to use evidence synthesis products which *have* assessed the quality of individual studies; (b) commission evidence synthesis products which assess the quality of individual studies or (c) seek to make a judgement about a body of evidence based on the criteria outlined above.
58. Five categories are proposed to determine the overall strength of a body of research when it is being applied to a particular policy or Business Case:

Table 1: Evaluating the overall strength of a body of evidence

| Categories of evidence | Combinations of quality + size + consistency + context | Typical features of the body of evidence | What it means |
|------------------------|---|--|--|
| Very Strong | High quality body of evidence, large in size, consistent, and closely matched to the specific context of the business case. | The body of evidence includes studies based on experimental designs (including impact evaluations), as well as systematic reviews and/or meta-analysis. ¹⁸ | We are very confident that the intervention has the effect anticipated or does not have the anticipated impact. The body of evidence has few or no deficiencies. We believe that the findings are convincing and stable. |
| Strong | High quality body of evidence, large or medium in size, generally consistent, and matched to the specific context of the business case. | The body of evidence is likely to include either experimental or quasi-experimental designs (including use of RCTs and statistical methods enabling causal identification). Observational research designs (including comparative case study methods) that make attempts at counterfactual analysis are also likely to feature in these bodies of evidence, as are systematic reviews. | We are confident that the intervention has the effect anticipated or does not have the anticipated impact. The body of evidence has few deficiencies. |
| Medium | Moderate quality studies, medium size evidence body, generally consistent, which may or may not be relevant to the specific context of the business case. Also covers limited number of high quality studies. | The body of evidence is likely to include studies from multiple designs (experimental and observational), but which have been assessed as being only of a moderate quality. The findings of the studies do not offer robust findings that can be derived and replicated across a range of contexts. | We are moderately confident that the intervention has the effect anticipated or does not have the anticipated impact. The body of evidence has some deficiencies. We believe that the findings are likely to be stable, but some doubt remains. |
| Limited | Moderate or low quality studies, small or medium size body, inconsistent, not matched to specific context of the business case | The body of evidence is comprised of studies based on varied designs and methodologies, which do not meet the minimum standards of research quality. Includes causal inference derived from single case studies in a limited number of contexts, and cross-sectional analysis performed in the absence of rigorous baseline data. | We have limited confidence that the intervention has/does not have the anticipated effect. Body of evidence has major and/or numerous deficiencies. Additional evidence needed to conclude that the findings are stable or that intervention has the indicated effect. |
| No evidence | No studies or impact evaluations exist | | We have evidence of need but no evidence that the intervention does or does not have the effect indicated. |

¹⁸ Meta-analysis is used to refer to “the statistical analysis of a large collection of results from individual studies for the purpose of integrating the findings. It connotes a rigorous alternative to the casual, narrative discussions of research studies that typify our attempt to make sense of the rapidly expanding research literature.” Glass, G.V., ‘Primary, Secondary and Meta-Analysis of Research’, *Educational Researcher*, 5 (10), 1976, 5-8.

59. It is not realistic to expect all categories of evidence to attain a ‘strong’ or ‘very strong’ rating, especially where there is a nascent field or discipline with a limited number of studies. In such cases ‘medium’ will often be the best achievable rating and will be good enough.¹⁹

Part V: Using and applying this guidance

60. Staff should be strongly encouraged by managers to follow the approach set out in this How to Note when assessing the strength of evidence. It should be used in conjunction with other materials²⁰ to maximise the use of evidence and to ensure judgements on the strength of evidence are well founded and consistent. Where possible, ThemeSites can be used to record and share appraisals of individual studies by staff.

61. There are implications for staff capacity in analysing, grading and using evidence as not all staff will have the same level of ability or expertise. ‘Collating, analysing and presenting evidence/research using statistical and wider analytical skills’ is one of four cross-cutting technical competencies for advisers which requires staff to be able to access, critically appraise and use evidence, demonstrating skills in the following areas:

- a. Understand a range of qualitative and quantitative research methodologies including the application of basic statistical methods;
- b. Critically appraise and assess the quality of published research and other potential sources of evidence;
- c. Interpretation, use and presentation of data and evidence in defining policy and practice.

62. Advisory staff will be expected to demonstrate basic technical competencies in these areas. RED will design and roll out the delivery of training modules in research and evidence to equip staff with the ability to analyse and interpret the strength of evidence in accordance with this How To Note.

¹⁹ This is also the conclusion of a review of grading systems in health research, which recognised that a high rating is not attainable for some disciplines. See Harbour, R. and Miller, J., “A new system for grading recommendations in evidence based guidelines”, *BMJ*, 2001, 323: 334-6.

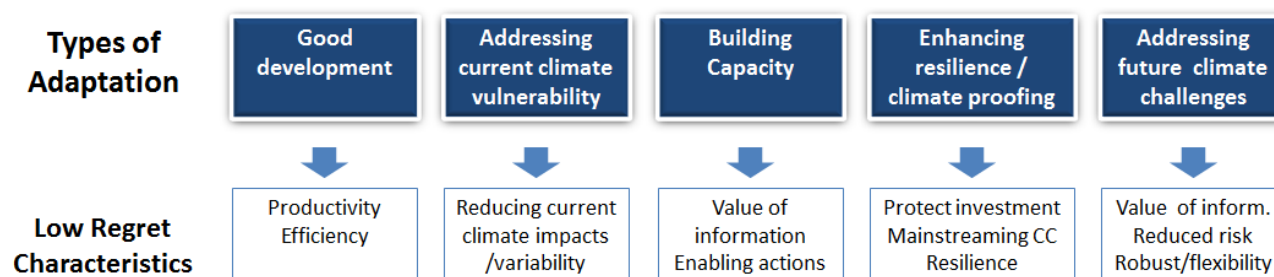
²⁰ See the ‘[Research Methods](#)’ guide pages on InSight; Evaluation Department’s Handbook, ch. 4, ‘[Choosing your evaluation approach \(design and methodology\)](#)’; Global Statistics Partnerships Team, ‘Using Statistics’ How to Note, forthcoming; *Evidence Broker’s Guide to Evidence Synthesis*, available from DFID’s Evidence into Action Team. Contact: w-evans@dfid.gov.uk; matthew-harvey@dfid.gov.uk.

Detailed Literature Review: Low and No-regret Options for Agriculture

Summary

As part of the Evidence on Demand framework contract, GCAP are undertaking a review and analysis for DFID on 'What are low regrets adaptation measures and do they offer good value for money?'

The study has developed a typology of the types of low and no-regret options, built around an iterative adaptive management framework for adaptation, considering different temporal and policy aspects from development through to future mainstreaming. This splits adaptation into five types of interventions, which involve different forms of low/no regret, and involve differences for the appraisal of adaptation benefits. The typology is summarised below.



Following an initial literature review, the study has undertaken a more detailed review of the agriculture sector, looking at the issues in applying this typology in a practical setting, and working with a set of initial decision trees that align to a possible toolkit.

The decision tree starts with the identification of current and future risks, identifies adaptation options, identifies which might be low/no-regret options, and then considers key issues and identifies useful information to guide users in the appropriate selection, consideration of transferability, information sources, etc.

The review has first considered the risks to the agricultural sector. This has found a very large number of current and future risks, which involve a large number of different climate parameters. These include the issues of current climate variability (temperature and rainfall trends), extremes (droughts, floods, storms), but also soil erosion, pest and disease, and others. Similarly, a very large number of different risks have been identified in relation to future climate change (though the quantitative evidence is heavily biased towards a small number of crops). The analysis of future risks is also compounded by socio-economic factors, and autonomous adaptation.

The analysis has then reviewed the potential adaptation options for agriculture to address these risks. The literature review has considered the adaptation literature plus five national climate change strategies. A key finding is that the adaptation literature is heavily focused around a small number of technical options (especially irrigation) while the national strategies identify many more options, with a broader focus (from options to capacity building), which align with the existing sectoral context.

The review information was then used to identify a set of options and map these to the typology above. This exercise found a very large number of types of adaptation options, because of the range of risks, the livelihood group/people or aggregation level, and type of adaptation option (technical, process, etc.). The full listing numbers hundreds of options / interventions, and many of the options are very specific to the context of the country or policy background.

However, in generic terms, it has been fairly easy to identify a generic set of options that seem to be low- or no-regret in nature, though this includes around 40 or 50 options. It would be

possible to provide information to help users identify these options and to highlight issues related to transferability, provide useful information sources and case studies, etc. However, even with this relatively small number of options, it would be difficult to provide a detailed decision tree that captured all the specific issues with each option.

An analysis of the literature and the options provides some important findings.

First, while some options fall distinctly into one category, a number potentially overlap. However, an important part of the typology concerns the information needed for appraisal of benefits, and for this reason, the typology does seem to work at the sectoral level.

Second, the detailed literature highlights that in many cases, options are more effective when implemented in combination (i.e. portfolios of options, such as combining improved seeds with soil and water conservation and better extension services). This is important for the subsequent toolkit, i.e. in highlighting that successful adaptation (and value for money) will require combinations of outcome and process based adaptation (and technical and socio-institutional interventions).

Third, it is fairly clear that options that address current climate variability are more risk and site specific, i.e. there are greater issues in the transferability of these options. Note that for agriculture, we have found less focus on the longer-term aspects, but this is because of the low levels of long lived infrastructure and fast adaptation response times.

Finally, some of the options have potentially high synergies with mitigation, e.g. climate-smart agriculture. It will be important to capture these synergies in the identification and prioritisation of options.

The study is currently applying the approach in a case study on Zanzibar. The typology and analysis has been used to try and help in identifying low and no regret options in the context of a climate change strategy and subsequent prioritisation and action plan. This has highlighted some useful lessons, from the perspective of using the approach and information needs:

- The typology is fairly logical to implement, and does help in filtering out more minor issues, i.e. it allows the focus on good early things to do (which would be consistent with VfM).
- Information on current risks was low (even in terms of the relative size of risks from current climate variability) and there was almost no useful information on future impacts. While this position maybe better for other countries the guidance probably needs to include information to help sources for risk identification.
- In some cases, there is quite a lot of technical knowledge needed in going from risks to selecting appropriate adaptation options, e.g. in the consideration of soil and water conservation and the application to the specific local context.
- There is also quite a lot of local knowledge needed, in terms of contextual information and policy baseline. Furthermore, there is often a conflict between the options identified and the existing views on preferred interventions, in this case between low regret measures of climate-smart agriculture, versus existing developing priorities for medium-scale irrigation.

Further analysis will be undertaken with the in-country case study visit.

Introduction

As part of the Evidence on Demand framework contract, GCAP are undertaking a review and analysis for DFID on

‘What are low regrets adaptation measures and do they offer good value for money?’

Following an initial literature review, the study held a workshop to discuss possible areas for a more detailed review. Two areas of early focus were identified, agriculture and disaster risks. These areas are likely to be priority areas for adaptation in all Least Developed Countries (LDC).

This paper provides the detailed literature review and analysis of relevant issues for a toolkit for the agricultural sector.

The paper is set out as follows. The overall framework and typology for low regret options is first set out. This is followed by a brief discussion of the potential climate risks to agriculture and the identification of adaptation options. These options are then analysed against the low-regret framework and

These options are then analysed against the framework, with the consideration of the issues that are important in assessing the low-regret characteristics.

The findings are used to develop some early decision trees for the low-regret toolkit.

Finally, the analysis and the toolkit are considered in the context of the proposed country case study, with early application in Zanzibar and consideration for Rwanda.

Framework and Typology

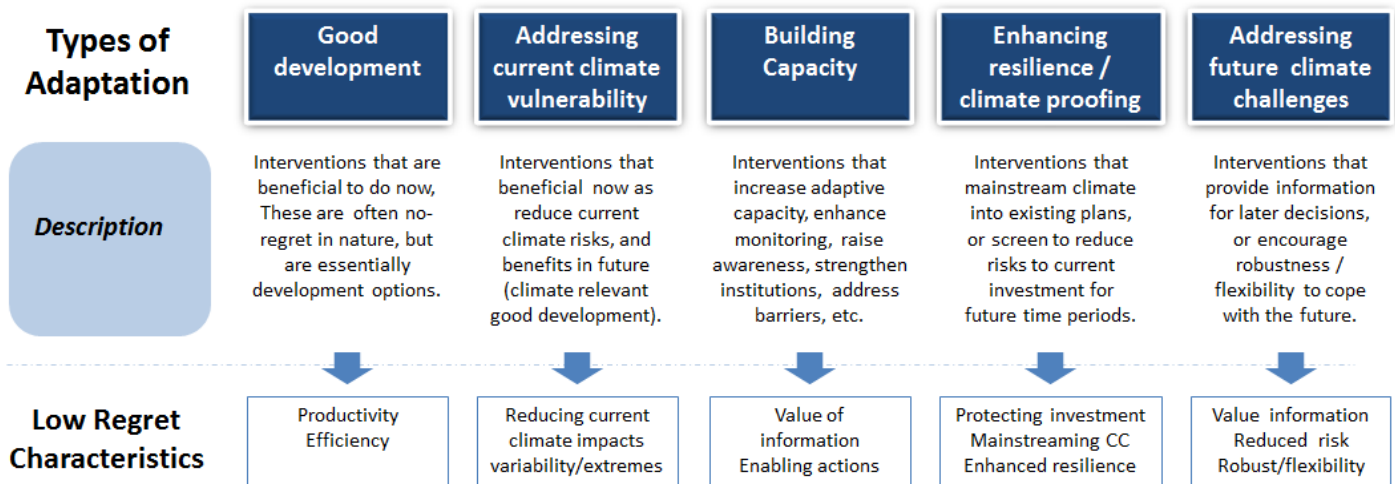
There is a well-accepted definition of no-regret adaptation options, i.e. projects or policies that generate net social and/or economic benefits irrespective of whether or not climate change occurs.

There is a much wider range of definitions of low-regret options. Some of these may reflect that no-regret options may not be as beneficial in all cases or locations, and some introduce additional elements of early adaptation options that are early priorities, especially when viewed from an iterative framework of adaptation. The low-regret options include:

- No-regret options which include opportunity, transaction or policy costs (which flip a no-regret to a low-regret).
- Where options provide additional ancillary benefits (notably environmental or social).
- Where costs are low and there are immediate benefits.
- Where costs are low, and there are future benefits.
- Capacity building, which provides information, research, awareness, etc., which helps in addressing current and future climate risks.
- Early actions to help prepare for the future, e.g. providing information, monitoring frameworks, early research or pilots to allow future decisions or scale-up, etc.
- Where adaptation can be incorporated at low cost in construction.
- Where adaptation can be included as part of ongoing replacement or renewal cycles.

- Where options provide benefits over most, though not necessarily all future scenarios.
- Where options provide flexibility.

Subsequent analysis of the types of adaptation interventions in the study has identified a broad typology of low- and no regret options, identifying five categories of types of adaptation, each with associated low- and no-regret options in each. This is shown below.

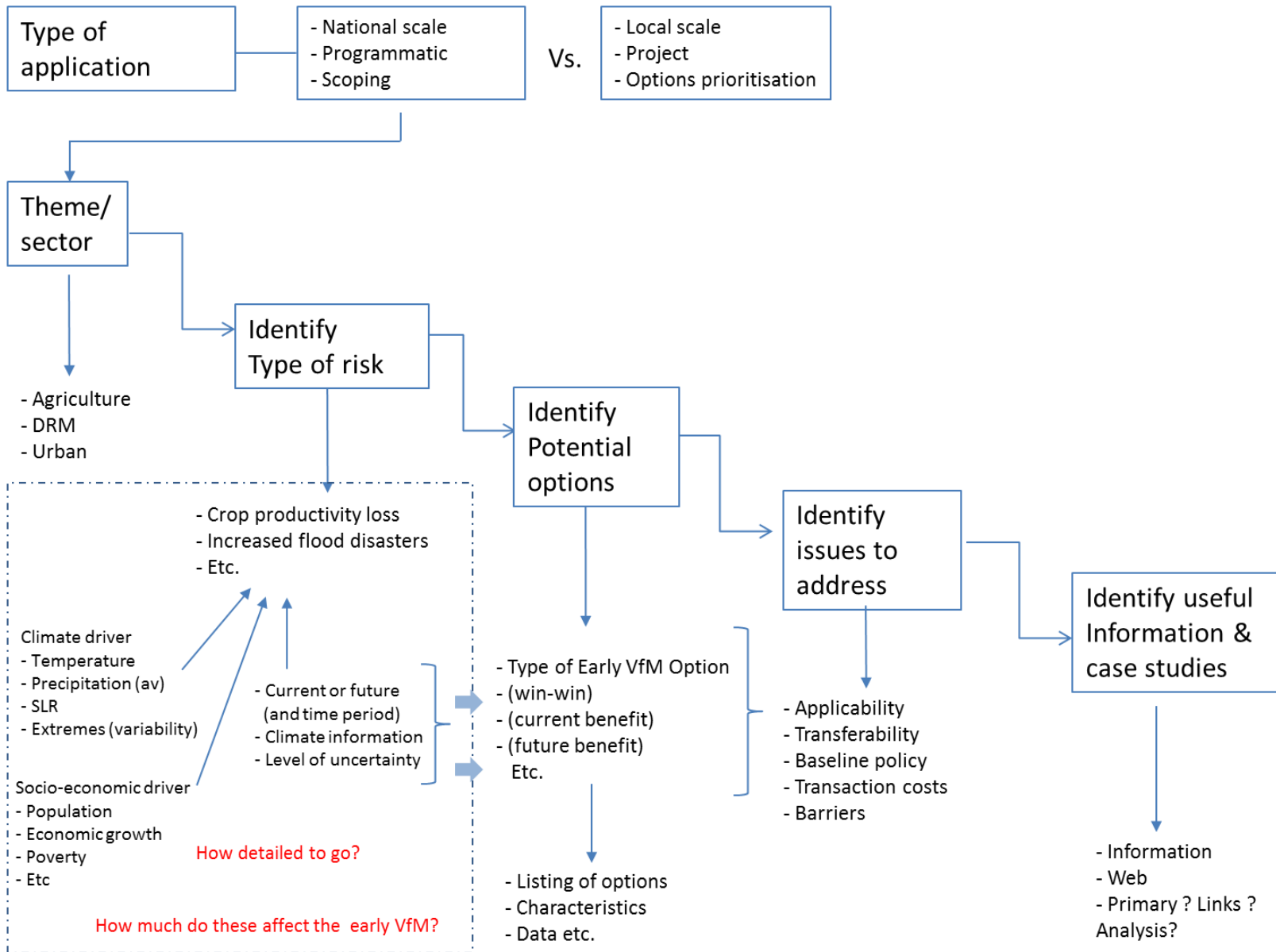


In broad terms, there will be potential examples of low- and no-regret options for agriculture in all of these areas, for example:

- Examples of good development would be general improvements in crop productivity, access to markets, rural roads, etc. These are not climate specific, but are often cited as no-regret options.
- Examples of climate relevant good development, i.e. which are addressing current climate variability, such as soil and water conservation. These are no-regret options as they increase productivity, but they do this by enhancing resilience against climate variability.
- Examples of capacity building, such as better agro-meteorological services, seasonal forecasts, climate information and extension services, research into new varieties, etc.
- Examples of enhanced resilience, such as considering climate change effects in irrigation proposals, or in additional resilience for rural roads.
- Examples of future information, e.g. monitoring programmes to track changes in pest and disease spread with climate, as well as robust or flexible options such as water efficiency rather than large storage projects.

In looking at the application of this typology to agriculture, it is important to match potential options, to look at how to identify benefits and costs (and thus value for money) and to look at the issues on the transferability of low-regret characteristics.

To do this an initial decision tree has been developed and applied (see below).



Defining agriculture

Agriculture includes a broad category of potential activities and system boundaries.

It is often focused on agricultural production, particularly on crops, and especially on cereals, but it does include cereals, pulses, simulants (e.g. tea, coffee), oil seeds, vegetables, sugar, spices, fibres (e.g. cotton), etc.

In theory, it can also include biofuels, as well as agro-forestry, which has close links to forestry.

This can include a very large range of production systems, e.g. subsistence/pastoralist, production, cash crops, and a range of size from small-holders up to large farms.

A broader definition includes livestock (cattle, dairy, poultry, etc.), which is important because in many developing countries mixed systems (crop-livestock) is used.

The consideration of agriculture can also include the wider value chains and systems, e.g. transport and access to markets, value chains and added value, markets (domestic, exports, international trade). It can also be extended to include the broader issues of food security.

Finally, in macro-economic sectoral classifications, agriculture is usually used to consider sub-sectors of crops, livestock (animals), fishing and often forestry.

All of these are potential relevant, though the more elements that are considered, the bigger the space to consider.

It is highlighted that the definition of agriculture will be defined by the policy context, i.e. the application of the guidance.

As an example, if looking to work with a sector line ministry in-country to provide an adaptation programme for agriculture, there is likely to be a strong orientation around the specific ministry organisation of this issue. It is stressed that these vary by country, e.g. crops, livestock, forests, and natural resources maybe in one ministry, and in some countries even include disaster risk management or water (linked to irrigation), livestock and fisheries may be included or separate, etc.

The Risks of Current Climate Variability and Future Climate Change

There is now an emerging consensus in adaptation to think about climate change as a series of problems, which starts with the current issues of existing climate variability and climate extremes and then looks at future climate change, and also adopts an iterative framing of adaptation (IPCC, 2012).

The starting point for adaptation interventions in the agricultural sector therefore have to consider these different elements.

Current climate variability

There are well documented risks to current agriculture in developing countries, which are captured in the captured in National Adaptation Programmes of Action (NAPAs)

Current climate variability has large effects on the agricultural sector of most countries, affecting household and farm revenues, and also sectoral GDP.

At the global level, recent studies report that higher temperatures reduce economic activity and reduce growth rates in low income countries. Dell et al. (2008) used annual variation in temperature and precipitation over the past 50 years to examine the impact of climatic changes on economic activity throughout the world. They report that higher temperatures substantially reduce economic growth in poor countries while they have a marginal effect in rich countries. Moreover, they find that higher temperatures appear to reduce growth rates in poor countries, rather than just the level of output. These findings are driven by the linkage to agriculture.

There is also a large body of empirical evidence that focuses on the impact at a micro (farm) level. These show that in countries where agriculture is primarily rainfed, there are also strong relationships between rainfall variability and agriculture productivity and sectoral GDP.

At the household or farm level, the relationships between the existing climate and households has been assessed through the use of household assessments and economic (Ricardian) analysis. Ricardian studies use regression analysis to consider how factors, such as climate, soil, and household variables, are correlated to land value or farm net revenues. A study at the African scale found that the elasticity of net revenue from farms with respect to temperature change is about -1.3 (Kurukulasuriya & Mendelsohn, 2009), i.e. one percent increase in temperature will result in a 1.3 percent decline in net crop revenue. Not unsurprisingly, farms in hotter and drier regions were found to be the most sensitive (with a temperature elasticity of -1.6). These effects happen because of the temperature specificity of where a crop grows best across the seasons - the optimal temperature varies from crop to crop and thus deviations from optimal conditions lead to lower production. These studies also show strong relationships with rainfall variability, though these vary with country and season. Ricardian studies have also been applied to consider livestock, including mixed farming systems. These show impacts of climate variability, e.g. higher temperatures and lower rainfall, affecting animal health and livestock productivity (directly or through food and fodder).

Related to the issues of climate variability is the frequent occurrence of **extreme climate events** (droughts and floods) highlighted are a major challenge to the agricultural sector. Droughts are complex phenomena that are typically classified in four types: meteorological, hydrological, agricultural and socioeconomic (Dutra et al. 2012). Meteorological drought is commonly defined as anomalous low rainfall, however, even a relatively small rainfall deficit can have a large impact and vice versa. The economic impacts of droughts are most obviously manifested through crops and livestock losses, and associated effects on production, but drought events have much wider economic impacts. Floods are also an important current risk for the agricultural sector, leading to inundation and crop damages, loss of livestock, etc. but again they include wider direct and indirect effects (and economic costs) across many sectors, including the contamination of water supplies, disruption to transport, etc. that have additional indirect effects on agriculture. For countries affected by storms (cyclones) additional damages to agriculture arise.

In addition to flood risks, heavy rainfall is a factor in **soil erosion** is a physical process that causes land and soil degradation, i.e. the erosion by water (though also by wind) and reduction in soil productivity due to physical loss of topsoil, reduction in rooting depth, and the removal of plant nutrients. Soil erosion is typically a major issue when there are steep slopes and high run-off from precipitation. It can, however, act directly and indirectly, e.g. in semi-arid regions the largest effects are thought to be the reduction in moisture-retention capacity due to erosion. It is also influenced by management practice (e.g. erosion control). Soil erosion has high economic costs, because of the loss of soil fertility, as well as problems downstream (e.g. siltation of hydro and irrigation infrastructure). Based on estimates of potential erosion rates for different crops in different parts of the world, Weibe (2003) estimated average annual yield losses for major crops to be 0.3 % globally, and estimated at 0.5% percent for Africa. Individual studies in some countries indicate much higher national or local impacts.

There are also linkage in the incidence and prevalence of some **pests and diseases** with climate. There are also additional risk for **coastal strip agriculture**, from risks of storm surge

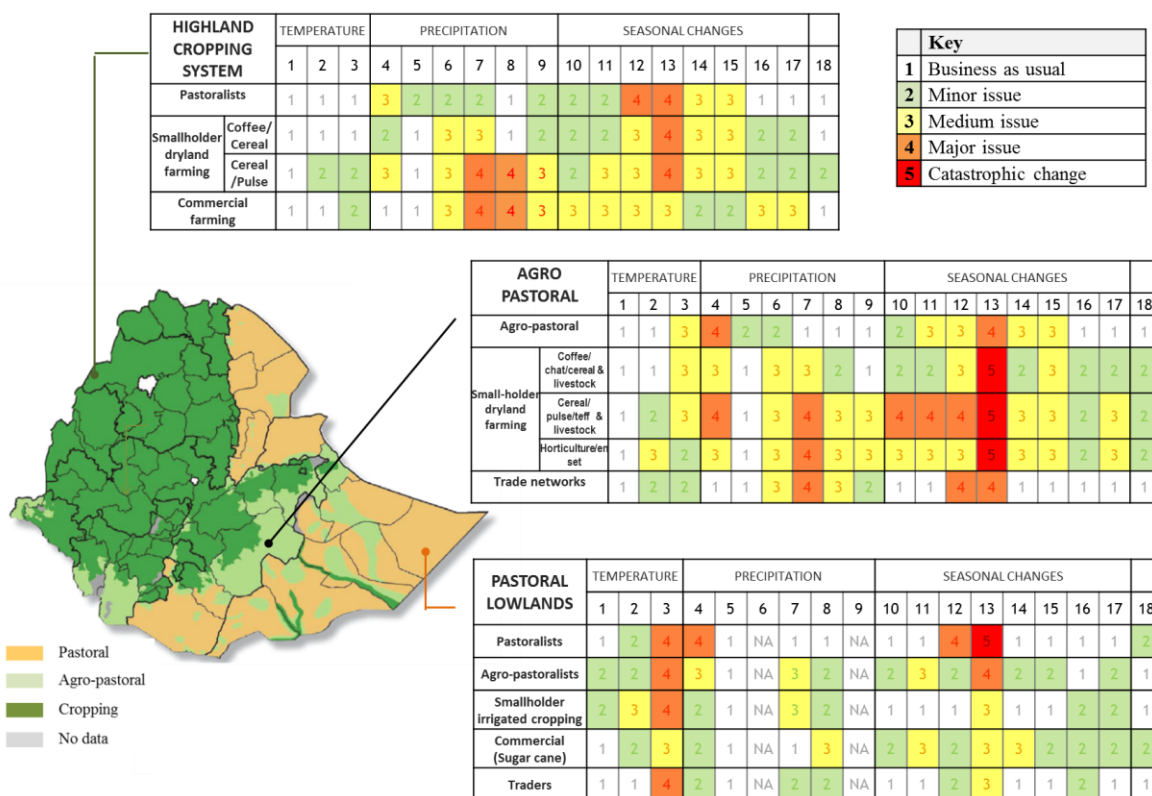
and salt-water intrusion (land inundation or contamination of water supplies). Finally, at the macro-economic level, for countries where agriculture is a high proportion of GDP, the effects above can translate into major impacts on GDP growth.

This does lead to a large number of individual climate risks, which will vary on a country and even local basis, and affect different groups (livelihoods, farming systems).

To illustrate, an example is presented from a recent vulnerability analysis of the agricultural sector in Ethiopia.

Examples of stresses of relevance to Agriculture: current variability and emerging trends.

| | Stress & threat | |
|----|---|--|
| 1 | Changes in mean temperature | Shifting agro-ecological zones, crop suitability, yield |
| 2 | Days with a max temperature above 35 °C | Heat stress for some crops, livestock, farmer productivity |
| 3 | Days with a max temperature above 40 °C | Extreme heat stress for some crops, livestock, farmer productivity |
| 4 | Reduction in days with a min temperature below 0 °C | Possible reduction in frost damage, but changes pest/disease |
| 5 | Mean rainfall decreasing | Shifting agro-ecological zones, crop suitability, yield |
| 6 | Mean rainfall increasing | Shifting agro-ecological zones, landslide, soil erosion |
| 7 | 3-day rainfall intensity increasing leading to flash floods | Damage to crops, livestock, infrastructure (transport) |
| 8 | 1-hour rainfall intensity | Landslide, soil erosion, crop damage |
| 9 | Heavy hail events | Crop damage (especially certain time in growing season) |
| 10 | Rainfall distribution within the season (variability) | Impacts on some crops |
| 11 | 10-day dry spells increasing | Impacts on some crops |
| 12 | Frequency of seasonal droughts | Impacts on most crops |
| 13 | Frequency of consecutive seasonal droughts | Significant impact on livelihoods and sector |
| 14 | Later onset of rainfall season | Shortens growing period - impacts on crops, fodder |
| 15 | Earlier end date of the rainfall season | Shortens growing period - impacts on crops, fodder |
| 16 | Decreased predictability of the rainfall season | Less reliable forecasts |
| 17 | Increased uncertainty in rainfall distributions | Increases risk, |
| 18 | Increases in cloudiness / humidity | Reduces radiation Increases thermal stress |



Source GCAP, 2013.

In reality, many of these impacts are highly complex, involve multiple factors, and vulnerability is dominated by socio-economic factors and underlying issues. This is particularly the case with the effects of drought for example.

It is also highlighted that the climate is changing already, and observational trends show increasing temperatures and sometimes changes in rainfall trends, variability, onset, etc.

Future climate change

There is now a reasonable evidence base on the potential effects of climate change on agriculture, which indicates potentially large effects (Rosenzweig and Parry 1994; Parry, Rosenzweig and Livermore 2005; Kururkulasuriya and Mendelsohn, 2006; Cline 2007; Easterling et al, 2007; Lobell et al. 2008; Schlenker and Lobell 2010). There is also a general understanding that tropical and subtropical agriculture in developing countries is more vulnerable to climate change than temperate agriculture (Mendelsohn et al, 2006). The fourth Intergovernmental Panel on Climate Change (IPCC, Easterling et al, 2007) suggests that at lower latitudes, in tropical dry areas, crop productivity is expected to decrease with even small local temperature increases in the region of 1 or 2° C. In qualitative terms, the literature indicates a large number of future risks, including the main risks outlined in the table below.

Examples of Important Risks from Climate Change

| Sector | Potential Impacts |
|---|---|
| Agriculture including cereals, cash crops, etc. | <ul style="list-style-type: none"> • Productivity changes: potentially positive as well as negative, from CO₂ fertilization, higher temperatures, changes in rainfall and rainfall variability, evapo-transpiration, changes in frequency and intensity of extremes including heavy precipitation and drought, involving many climate variables and impacting on many aspects of crop production, e.g. growth rates, development and flowering, maturity periods, etc. • Changes in length or timing of seasons. • Direct and indirect losses from extremes, e.g. direct loss of crops, damage and disruption to infrastructure. • Changes in pests and diseases (range of species and prevalence/incidence). • Changes in soil erosion (from changes in climate parameters, i.e. wind and water notably heavy precipitation) • Changes in soil conditions, hydrology, fertility and soil and land degradation (including desertification) • Changes across the value chain, effects on farm incomes, commodities, growth etc. and to livelihoods (e.g. health). • Changes in water availability (irrigation, supply and demand balance, etc.) |
| Livestock including poultry | <ul style="list-style-type: none"> • Productivity changes from climate variables (temperature, humidity, etc.) affecting animal health, growth, quality, reproduction, value, etc. • Increases in animal mortality, injury, reduced health or increased stress from extreme events (heat, drought, floods) including risks to housed animals (poultry). • Change in water availability. • Change in livestock feed availability / forage crops and feed quality. • Changes in disease and pests (range of species and prevalence/incidence). • Changes across the value chain, effects on farm incomes, commodities, growth etc. and to livelihoods (e.g. health) |
| Socially contingent | <ul style="list-style-type: none"> • Changes in suitability and sustainability of current agro-ecological zones, and livelihood zones / livelihoods, such as pastoralists. • Changes to food security, likelihood of famine. • Changes in livelihoods, society, increasing pressure, potential conflict, etc. |

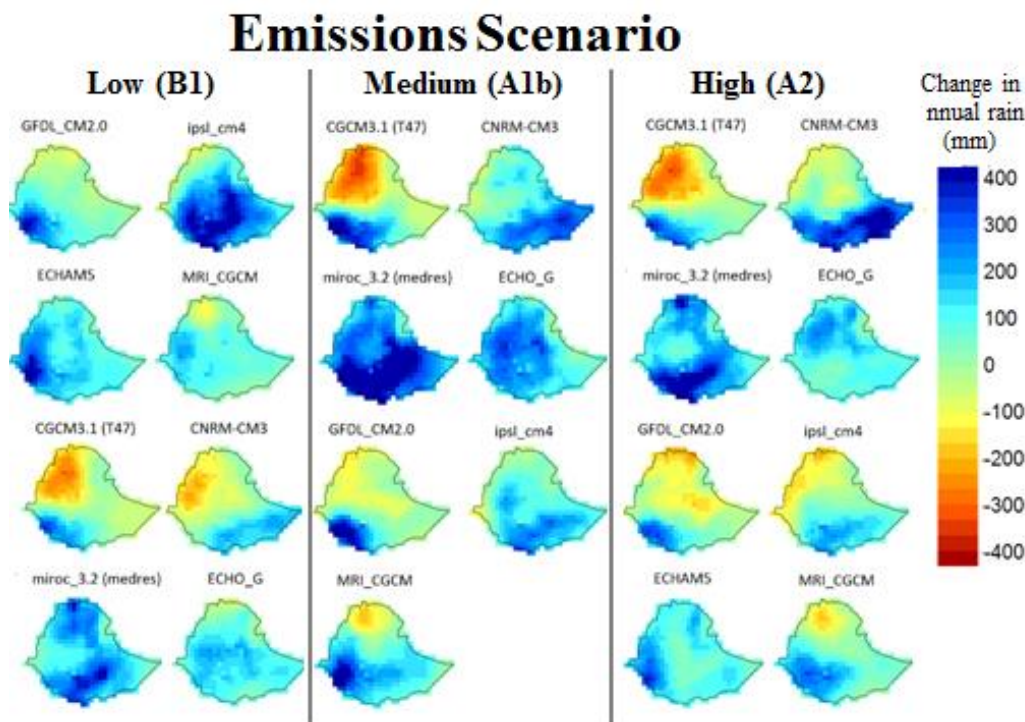
(Source: Easterling et al, 2007; Strzepek and McCluskey, 2006; Reason et al., 2005; Agoumi, 2003; Dinar et al., 2009 Fischer et al., 2005; Kururkulasuriya and Mendelsohn, 2006; Thornton et al., 2006; Seo and Mendelsohn, 2006; Dinar et al., 2009).

These risks arise from a combination of slow onset events (changes in average trends) and changes in variability and extremes. Again, the convergence of all these effects acting together is extremely complex, and the pattern of impacts will vary across regions and other time.

While the balance of risks are likely to be negative, it is highlighted that in some cases, countries, regions, etc., there is the potential for positive as well as negative effects, and therefore potential opportunities.

Future climate model projections

In looking at the potential risks of future climate change, a key issue is the uncertain associated with future projected changes of climate. These arise from two elements. First, the future socio-economic and emission pathways, e.g. whether we are on a low (e.g. 2 degrees) or higher emission pathway. Second, the uncertainty from different climate models, noting some climate variables that are important for agriculture, such as rainfall are much more complex and difficult to model. As a result, even for a single scenario, different models indicate a considerable range of outcome and can even lead to a change in sign (an increase or a decrease in rainfall) with different models.



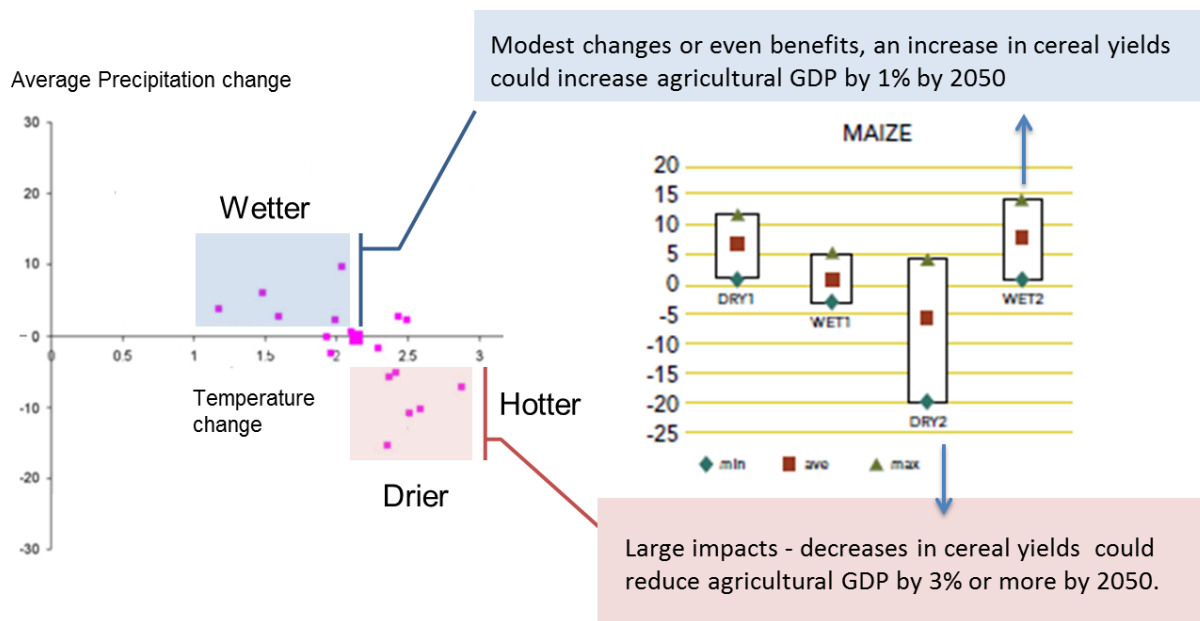
An example of the projections of annual rainfall for Ethiopia showing the differences between scenarios and models. It is difficult to discern any strong trends, and these are amplified when dropping down to individual regions, and for more complex parameters such as daily values, onset, variability and extremes. Source 8 CMIP models. Source GCAP, 2013.

Future assessment of climate change (crops)

The analysis of future impacts from climate change has applied two main approaches to quantify the main primary impacts of climate change on agriculture: crop models and Ricardian (econometric) analysis.

There is a significant body of literature that has applied **crop models** (agronomic models), which simulate the soil-plant-atmosphere components relevant for plant growth and yield, to look at the effects of future climate change on crop productivity. These studies often indicate that there will be a fall in productivity of agriculture in developing countries following a rise in temperature and a decrease in rainfall, however, under some scenarios or for some regions, they can show

benefits (i.e. productivity increases). The projected changes in productivity depend on the future temperature, but more importantly, the future precipitation and water availability, particularly in drier projections. They also depend on the assumptions about CO₂ fertilisation, which has beneficial effects in increasing production as GHG rise. Note that the changes in projected climate (see above), cascade through to uncertainty on impacts.



An example of how the uncertainty in climate model projections cascades through to the crop models. (Source GCAP, 2013, crop modelling, WB, 2010, EACC Ethiopia).

Most studies focus on key crops (wheat, maize and rice) though many of the models can assess up to around 20 different crops, and different varieties amongst these. Nelson et al., 2009, Muller et al., 2010, and Calzadilla et al., 2009 are example of crop models or crop models combined with partial (e.g. IFPRI's IMPACT model) or a computable general equilibrium model (e.g. GTAP-W). Although crop production impacts across studies vary by magnitude and, in the case of Muller et al. 2010, direction, most agree that production impacts will be large and negative for a variety of important crops in Africa. However, effects vary with the CO₂ fertilisation effect, with this often switching the sign of effects, e.g. Muller et al., 2010 projects relatively smaller production changes of -7.6% without CO₂ fertilization effects, but +7.5% increases with then.

Ricardian studies consider the long-term productivity of land, and the effects of climate (and other influences) on land value or farm net revenues. They use regression analysis to consider how factors, such as climate, soil, and household variables, are correlated to land value or farm net revenues. They can then apply the changes in variables from climate projections to see how these affect revenues. As an example, Kururkulasuriya and Mendelsohn (2006) use such methods to model farmers' reactions to climate change under two types of climate scenario across 11 countries in Africa. Under the uniform scenario, the results indicate 2.5°C warming leads to losses of \$23 billion for dryland systems, but a gain of \$1 billion for irrigated cropland.

Both crop models and Ricardian approaches have many limitations in the application to climate change, and thus results from these must be taken with caution. Any results are influenced by the climate parameters assessed (single vs. multiple, average vs. variability), the inclusion or exclusion of CO₂ fertilization (or assumption about how important this is), the method used, and even the specific model (or group using the model). Moreover, these studies do not fully capture the complexity of climate change trends, whether from climate variability and extremes, or from the complex interactions that exist from local (plant or tree level) right through to implications from changes in international trade at the global level. Some care must therefore be taken in interpreting the current findings: a narrow consideration of productivity may miss key issues of

long-term soil degradation or complex patterns of variability and extremes. Further, it is important to consider the range rather than central findings, otherwise specific options could be recommended that would not be warranted under a different scenario (e.g. if a wet scenario projects floods are likely increase, the answer might be to invest in enhanced water control to improve protection, however, this large-scale investment might not be warranted under other scenarios).

When expressed in economic terms, the results also depend on the global inter-linkages assumed, i.e. the relative changes in agriculture that occur elsewhere in the world.

Any potential impacts also need to be interpreted in the context of other changes. There are policies and programmes in place that are increasing the value chain efficiency across the agricultural sector in most developing countries, and these help build adaptive capacity and reduce vulnerability. There will also be positive autonomous adaptation responses from farmers: who will react as the climate changes to reduce income loss, e.g. by shifting to different cultivars or crops.

Future assessment of climate change (other impacts)

There are a large number of additional impacts that are not captured above that are important additional risks for agriculture.

Soil erosion rates have the potential to be affected by heavy rainfall, and projections of future climate change suggest that there might be an increase in the intensity of high rainfall events (Allan et al, 2010; Meehl et al., 2000). A major scientific theory underpinning this result is that a warmer atmosphere will be able to hold more water, thus more will be available for a given rainfall event. This has the potential to increase current soil erosion rates.

These same projections of increases in rainfall intensity are likely to be relevant for floods, and it is possible to study changes in flood frequency and intensity with hydrological models, and then assess potential changes in flood events, but this is resource intensive and generally requires work at the basin level.

There may also be impacts on agriculture from the impacts of rainfall extremes on the supporting infrastructure, including roads. The EACC study (World Bank, 2010) highlighted that extreme rainfall events are particularly damaging to unpaved roads.

Similarly, climate change has the potential to affect droughts, but the complexity of existing events and the lack of good detailed information from the climate models makes it extremely difficult to project the future effects of climate change (given there is high uncertainty even over annual or monthly precipitation trends from the climate models—the projection of highly complex drought events is challenging and results can only be considered exploratory). These meteorological events must then be further translated into agricultural and socio-economic droughts and the associated impacts, which involves complex pathways (or else extrapolation based on historical analogues).

At the global level, climate scientists have reported a “medium confidence” that climate change has altered global drought patterns, and will in the future, though there is significant regional and local variation. The latest studies and results support this conclusion, e.g. Dai (2010: 2013). However, regional studies show wide variations, for example in East Africa, some models indicate decreases in droughts while others project increases.

There are also a much wide set of issues around water availability and water management, especially relevant for irrigated crops or water intensive crops (e.g. sugar cane). These involve cross-sectoral linkages in relation to future water supply and demand, and the impact of climate change.

Some agricultural systems will have additional risks, such as coastal strips, because of the risks from sea level rise, and the associated risks of erosion, inundation, etc.

Climate change also affects livestock production and productivity both directly and indirectly. The direct effects include temperature and other climate factors (humidity, wind speed) on animal growth, milk production, wool production, reproduction and general animal health, while the indirect effects include climatic influences on availability of water and the quantity and quality of feedstuffs such as pasture, forage, grain and the severity and distribution of livestock diseases and parasites (Easterling et al, 2007; NMA, 2007). These may lead to effects such as mortality (from heat stress), declining productivity or quality (value) or affect production costs, and they may even affect the viability of existing livelihood systems (from changes in the suitability of areas due to bioclimatic shifts) that rely critically on these animals. One of the main risks is from thermal stress from higher temperatures, which reduces productivity (meat and milk) (directly and from reducing intake of food and feed), affects reproduction and can lead to animal mortality. Some species, including housed animals, appear to be very vulnerable to heat, including poultry (chickens) which have relatively narrow temperature tolerance ranges (above which reproduction and growth are negatively affected). Any changes in climate variability and especially changes in the frequency and severity of droughts will also affect livestock, particularly in high risk areas in pastoralist zones. There are also additional threats from potential changes in the pests and diseases that affect livestock, as changes in climate could modify the range of these diseases, as well as potentially increasing the prevalence in existing areas. Many of these pest and diseases are already important in terms of the economic damage they cause.

There are also a set of broader issues at the macro-economic level, associated with future risks to the key drivers of growth for the economy, noting also the future effects of socio-economic growth in increasing adaptive capacity. Climate change has the potential to affect human capital accumulation, the sustainable management of natural resources, resource productivity, access to markets and credit, the quality of infrastructure and even macro-economic stability (Vivid, 2013).

Future assessment of socio-economic factors

In considering future vulnerability to climate change, a critical step is to consider how future socio-economic development might change over the next few decades. This is important because these socio-economic changes – such as population growth, the size of the economy and land-use development - will affect future vulnerability, impacts and adaptation. As an example, future population growth will increase demand for water and for natural resources, put pressure on agricultural land, increase demand for food, etc. Previous studies show that these future non-climate drivers are as important as climate change in determining future economic costs. These are important - failure to take future changes into account assumes that future climate change will take place in a world similar to today – however the analysis of these factors is complex, especially when considering detailed sectoral policy and development pathways.

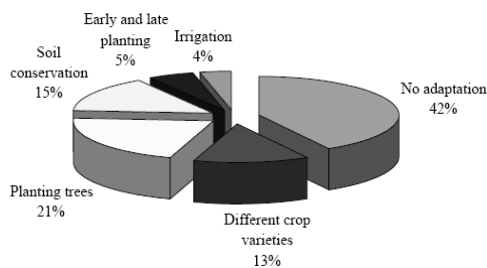
Autonomous adaptation

Farmers already use a wide variety of practices to deal with current climate variability, though the fact that this still exists indicate barriers to widespread uptake.

Climate shocks in particular lead to coping or adaptation strategies, particularly at farm level (so called autonomous adaptation). As an example, in Ethiopia, commonly used coping strategies include changing agronomic practices (e.g. use of short-maturing crop varieties), changing the livestock mix and reducing livestock numbers, sale of assets such as livestock and agricultural tools, reduction of consumption levels, collection of wild foods, loans from money lenders, seasonal migration, livelihood diversification including engagement in off-farm activities and farm level land and water management activities (Bewket and Alemu, 2011; Bewket, 2012). The effectiveness of these various coping strategies depends on the severity of impacts, and some

lead to asset depletion and increased vulnerability of households and communities after the immediate event.

The level of existing action can be surprisingly high. IFPRI (2008) found that at the farm level, farmers are adapting to climate variability and recent trends through the use of different crop varieties (the most common approach), tree planting, soil conservation, early and late planting, and irrigation, and around 60% of farmers surveyed had taken some action.



Autonomous adaptation methods used by farmers. Source IFPRI (2008).

Farmers will also react in the future to climate change, even in the absence of planned Government intervention, i.e. there will be autonomous (farm-level) responses to climate change. These are important because they change the baseline risks. The level of autonomous adaptation has been an issue in the studies highlighted above. Some studies (notably crop models) assume farmers sit back while major impacts occur (so called dumb farmers), while other studies assume farmers will adapt (notably ricardian approaches can build this in) though the assumption of perfect foresight and responses is normally assumed, thus the effects are considered to be overestimates.

Adaptation Options

Literature studies

There have been a large number of studies looking at climate change adaptation for agriculture.

Most impact orientated modeled studies of agriculture adaptation seek to work within a quantitative or economic framework using crop models, and only consider a small number of adaptation options, primarily assessing the role of irrigation as an adaptation strategy, or increased fertilizer use (e.g. Calzadilla et al., 2009, and similar country studies).

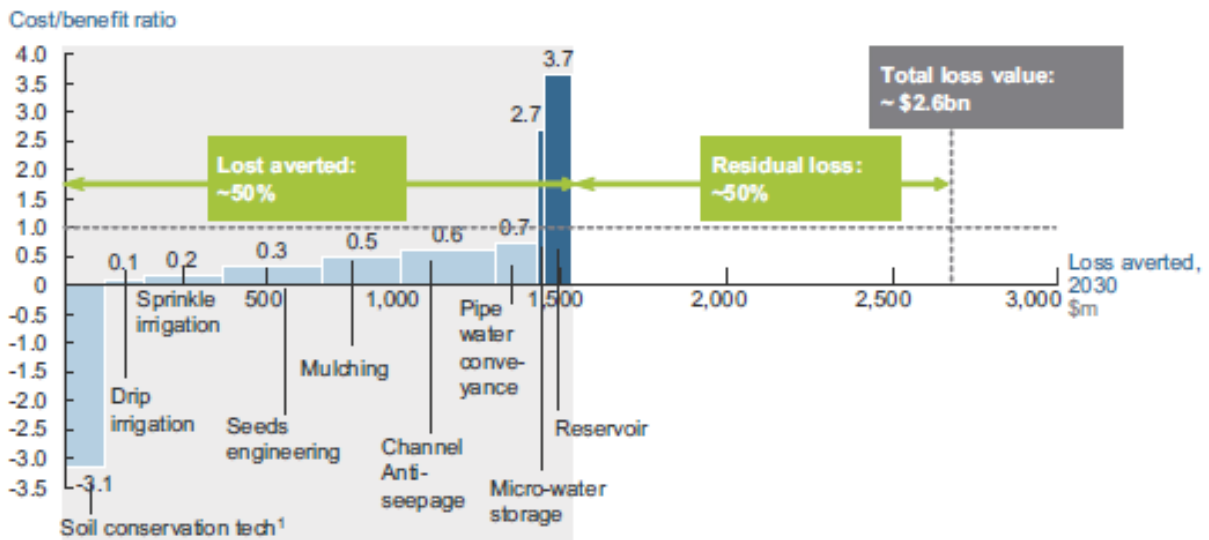
McCarl, 2007, in the 2007 UNFCCC Investment and financial flow analysis considered general mark-ups on research, extension services, and fixed capital formation across public (domestic and foreign) and private investors to estimate adaptation costs. Parry et al (2009) highlight that these estimates in the UNFCCC study, and other similar studies, have a number of deficiencies.

IFPRI (Nelson et al., 2009) for the World Bank economics of adaptation to climate change (EACC) global analysis (2009), explored the costs of productivity-enhancing investments that reduce child malnutrition. The analysis considered four generic adaptation strategies, agricultural research, irrigation efficiency, irrigation expansion and roads. These same categories were generally used in the EACC country studies, with estimates of adaptation costs for research, irrigation and roads.

However, these studies have little resonance with real adaptation, they are largely theoretical technical assessments that assume perfect foresight and work with a small number of technical options (irrigation), using unit costs and a predict-than-optimize framework to derive estimates of the benefits of irrigation against the costs of implementation.

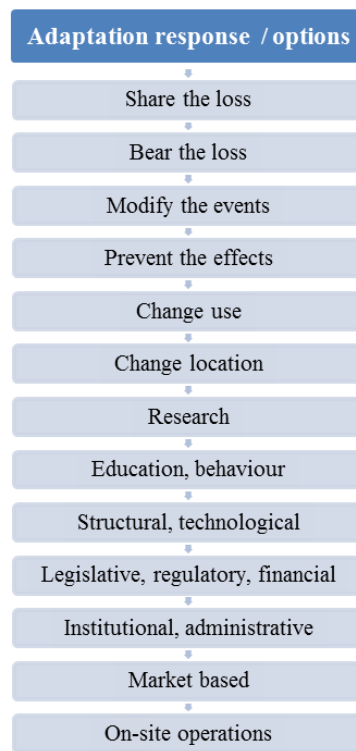
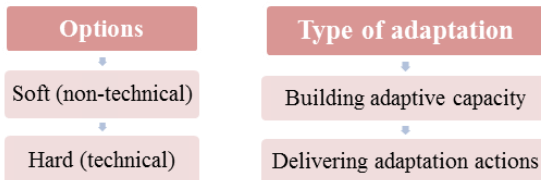
Furthermore, these align to a small part of the risks and the sector, i.e. they focus on average temperature and rainfall trends on a small number of cereal crops.

The Economics of Climate Adaptation (2009) study on Shaping Climate-resilient Development undertook adaptation cost-benefit analysis and presented the results as marginal adaptation benefit:cost curves (to look like mitigation marginal abatement cost curves for cost-effectiveness analysis). Case studies on climate risk in India, China and Mali were undertaken. However, the study focused down on a narrow set of water management measures where costs are well understood (irrigation) with a few additional options where quantitative information is available (e.g. soil conservation).



However, in practice there are a very large number of options for the agricultural sector, which involve responses to the wide range of risks highlighted above, across current and future climate regimes. These involve many different types of options or interventions. Adaptation can be planned or autonomous, respectively responding in an anticipatory or reactive way. It can involve public and/or private sectors. It can be applied at multiple geographical scales (farm-level, local, regional or national) and temporal scales (immediate to long-term). Finally, it can vary from individual project level interventions, such as technical equipment, right through to policy interventions or institutional change, including the enabling environment.

| Types of Adaptation | | |
|---------------------|--------------|------------|
| Intent | Autonomous | Planned |
| Action | Anticipatory | Reactive |
| Time | Short-term | Long-term |
| Scale | Local | Widespread |



The analysis of all the different possibilities can lead to very long-lists. Watkiss et al (2013) for Ethiopia identified almost 1000 options from the literature, and even when summarised and grouped, found a very large number of types, depending on the risk being tackled, and the livelihood group/people or aggregation level, and type of intervention .

| | |
|--|---|
| General agricultural adaptation General crop adaptation, e.g. change varieties, diversification Change crop traits, e.g. drought tolerant, water efficient Crop research and development, e.g. plant breeding Maintenance of traditional varieties and genetic diversity Soil Inputs (fertilizer), e.g. use, application rate Labour, e.g. Change use of capital and labour Farm management, R&D, technology, e.g. agricultural research Increase irrigation (see also water below) | Livestock Breeding, e.g. drought resilient Herd and species diversification Animal health (e.g. vet services, monitoring) Fodder improvement Forage improvement Changes in practice Conservation/land use policy for pastoralist area |
| Improved infrastructure / access to market New road infrastructure (rural roads) Improved road infrastructure (paved roads, standards, drainage) Improved market access through transport | Institutional Land and property rights (tenure) Institutional development Environmental regulation and monitoring |
| Water Irrigation (small-scale and large-scale, alternative technologies) Water harvesting Water storage (ponds to dams) Drainage Water resource management (integrated)/ river basin planning Improved water efficiency Water allocation (and pricing) Wetland recharge and management Hydrological monitoring and measurement Research and development, capacity building | Capacity building, knowledge and information Meteorological services. Monitoring and forecasting Improved climate modelling and climate research (institutes) Improved vulnerability assessment Improved communication of information (to farmers) Awareness raising at all levels, through various ways Community participation and education Knowledge and technology transfer, e.g. extension services, farmer to farmer |
| Sustainable agriculture and land management Soil management, e.g. conservation agriculture, crop residues Erosion control, e.g. bunds, edge planting, mulching, terracing Agroforestry Soil moisture management and conservation Land and watershed management (integrated) Promotion of biodiversity in agriculture Sustainable land management Research and development | Forestry Monitoring and surveillance Conservation Reforestation and new planting Diversification Development and commercialization (NTFP) Planting climate resilient varieties Improved forest management practices Seed storage and nurseries Research and development Fire management Policy and institutions Payment for ecosystem services |
| Conservation/rehabilitation Protection and rehabilitation of ecosystem (services) Wetland conservation and restoration Land conservation | |
| Disaster Risk Management Early warning systems Monitoring and prediction Flood risk management Flood control (structures) Movement/resettlement Insurance (micro, index linked, etc) | Safety nets Enhancing asset base Enhanced/extended safety nets Strategy and planning Flood control (structures) Community seed/storage |
| | Livelihoods Livelihood and income diversification Asset creation and protection Changing livelihood types Community institutional strengthening |

This analysis has been complemented by a review of the types of adaptation options recommended in National Climate Change Strategies. More details are in the appendix.

Some countries (e.g. Tanzania, National Climate Change Strategy, 2013) have produced long-lists of adaptation options for the agricultural sector (around 50 options). These highlight the sort of areas that are similar to those in the figure above, but that are still highly generic in nature, e.g. promoting irrigation systems, promoting early maturing crops, and do not consider the issues of which systems, which crops, which areas, what barriers are involved, etc.

Rwanda (Green Growth and Climate Resilience -National Strategy for Climate Change and Low Carbon Development. 2011) is more focused, identifying a number of key strategic objectives, and then looking at policies to advance those. It identifies programmes of action around the sustainable intensification of agriculture, and agricultural diversity in local and export markets,

It therefore picks out options that align with these objectives, e.g. for sustainable agriculture:

- Mainstream agroecology techniques using spatial plant stacking as in agroforestry, kitchen gardens, nutrient recycling, and water conservation to maximise sustainable food production;
- Utilise resource recovery and reuse through organic waste composting and wastewater irrigation;
- Use fertiliser enriched compost; and
- Mainstream sustainable pest management techniques to control plant parasites / pathogens.

and for agricultural diversity:

- Expand crop varieties for import substitution and climate resilience;
- Add value to those products through processing to meet its own market demand for food stuffs;
- Develop decentralised village-based agricultural processing centres that incorporate low-carbon sources of energy, such as biogas-digesters and solar driers; and
- Develop niche export crops under organic and fair-trade branding.

However it can be seen that these are very focused on general development, rather than on climate change. Interestingly it did adopt of form of qualitative analysis to identify the relative benefits of options.

Kenya, in its recent (2013) National Climate Change Action Plan 2013-2017. set out a vision for a low carbon climate resilient development pathway. It highlights climate-smart agriculture as a major pillar, and focuses on major programme scale up for a small number of options:

- Agroforestry. This has the potential to abate 4.2 Mt CO₂e by 2030, while offering climate resilience benefits of improved food security, soil quality, improved soil water retention, reduced erosion, and perennials that are better able to withstand climatic changes.
- Conservation tillage and limiting the use of fire in cropland and rangeland management has the potential to abate 1.1 and 1.2 Mt CO₂e by 2030, respectively.
- Actions to support climate change adaptation in the highly vulnerable yet naturally resilient Arid and Semi-Arid Lands (ASALs) include improved management of grazing systems, livestock diversification, and breeding techniques as well as the provision of accessible climate information to farmers and pastoralists.
- Other actions including promotion of drought tolerant crops, water harvesting, integrated soil fertility management, insurance schemes, price stabilisation schemes for livestock, strategic food reserves, and mainstreaming climate change into agricultural extension services.

The National Climate Change Adaptation Strategy(NCCAS) for Land Based Resources - Government of Fiji, sets out a long list of specific options, with allocated responsibility and key performance indicators.

Overall, this exercise found a very large number of types of adaptation options for agriculture, depending on the risk being tackled, and the livelihood group/people or aggregation level, and type of adaptation option. It numbers hundreds of options / interventions, and many of the options are very specific to the context of the country or policy background.

Assessing Adaptation Options by Type of Adaptation/Risk

To progress the analysis, the review focused down on the information from the information above and looked to map the types of adaptation options against the typology.

Good development

The list of potential adaptation options that fall into the general category of good development is very large. The fact that this does not concentrate on specific risks, but just looks at good options to improve productivity, and thus build resilience, means that it can cover almost anything across the agricultural sector.

In most cases, the measures are anything that addresses the problems of small scale subsistence farmers in the LDCs, who have low levels of technology, limited farm inputs, low access to finance/credit services, limited extension services, inadequate transport networks and high transport costs, low market information, lack of information (or access to information) on climate variability, forecasts, etc. low level of education, and low coping capacity in relation to non-agriculture-related activities, such as income diversification (Di Falco et al, 2011, Rijkers et al, 2010). World Bank, 2010). They also suffer from high losses from pests and diseases, reducing crop production and high levels of post-harvest losses. They can also cover difficult social or political issues, notably around land tenure. Tenure and secure access to land and land use planning play a crucial role for achieving poverty eradication, food security and sustainable development (see Place, 2009) but some studies suggesting this makes farmers more likely to take action for adaptation (Bryan et al, 2009).

Note that because of the importance of subsistence farming, and the key role that agriculture and livestock plays in livelihoods, particularly in rural areas, the analysis of the agricultural sector extends beyond production to the wider consideration of livelihoods, food security and disasters.

The long list of possible interventions in this area makes it difficult to know where to start. Furthermore, many would argue that as this is effectively just good development, it should not be a focus of adaptation funding.

However, the problem is that unless these underlying issues are addressed, adaptation will not be as effective, and the potential returns (benefit:cost ratios) for these basic interventions are far higher than for many adaptation interventions (see example below), thus it is questionable given resource constraints, why development partner investment should not flow first to these areas before addressing climate.

| Practice | In drylands of Africa | Remarks |
|---|--|--|
| A. Optimum time of planting | Up to 50% yield increase output in dry areas is possible | Considerable research has already been done for dry areas of Africa. |
| B. Improved spatial arrangements and plant population | Up to 20 % increase in yields | Only a well-coordinated extension effort is required. |
| C. Improved field preparation and tillage practices | Up to 30% in drier areas and areas with "difficult" soils in the humid zone. | A lot of, as yet unfinished, research is being undertaken. |
| D. Use of the best variety available | Up to 30% in large areas. | Development is very fast |
| E. Better fertilizer | Up to 50% in large areas | In Asia, there is a good database on fertilizer response. In Africa less satisfactory. |
| F. Better weed control | Up to 40% in many areas. | Can very easily be improved. |
| G. Better pests and disease control | Up to 30% almost everywhere | Much more research is required everywhere. |

Source: Georgis, 2005

Moreover, in many cases, these basic options are standard adaptation responses to changes in rainfall regimes, e.g. fertilizer application and enhanced irrigation are adaptation responses to falling rainfall levels (and are the standard responses included in climate change modelling studies).

Finally, it is apparent that in terms of sectoral investments, line ministries are keen to use adaptation finance for programmatic investment gaps, notably in areas such as irrigation and agricultural development. A number of specific options are highlighted below.

One of main responses identified in the climate change literature from crop models is the use of additional inputs or more efficient use of inputs, notably **fertiliser** to compensate for the yield losses from climate change. It is highlighted that the use of conventional fertilisers does increase GHG emissions, thus the alternatives of organic manure or other organic residues, and more sustainable agriculture is preferable. The potential benefits (and costs) of increased fertiliser use

are well studied, and enhanced fertiliser use is a key adaptation in the crop based modelling assessments of adaptation.

Again, a general improvement in **agronomic management practice and technology** can improve agricultural production and help address climate change, ranging from use of labour, diversified crop rotation or mixed farming through to technology and mechanisation. Indeed, agronomic management including soil fertility condition, pest and disease control are more critical in determining crop yield, and the potential of improved varieties can be exploited only when integrated when in combination with improved agronomic management practices. Further, new cultivars are generally more responsive to higher input use (such as water and fertilizer) enabling greater increases in production when combined strategies are implemented.

There are high existing losses from pests and disease in many LDCs and addressing these offers the potential to improve current productivity as well as reducing the potential impacts from increased or new risks from climate change. This leads to a set of options around **pest and disease management** monitoring, surveillance and responses to the spread and development of plant disease, as well as more resilient varieties (to address current risks). A related aspect is the high level of post-harvest losses currently; again, actions to reduce current losses increase general resilience and management activities or improved storage facilities will help build resilience.

Finally, and in most studies, irrigation is a focus of many countries agricultural growth and development plans. **Irrigation** (large, medium or small-scale) helps to increase productivity and reduce the impacts of climatic variability and many forms of drought – as an example, studies in Ethiopia report irrigation doubles net gross margin for farmers. These generally report high benefit to cost ratios (e.g. 3 to 5) (Watkiss et al, 2013, Evans et, al 2012; Gebrehaweria 2011). Irrigation is one of the most common farm level options recommended in adaptation assessments, particularly through the use of crop models, is to increase irrigation to address future climate change. It has the advantage that such measures can be relatively easily costed, through the increase in irrigated water delivered and the cost per unit of delivery (\$/m³ or \$/hectare), though there are a wide range of sub-options, including small, medium and large-scale irrigation, and variations in level and type of technology. Many studies also highlight potential for small-scale irrigation and rain-water harvesting (RWH).

Numerous studies highlight that **access to credit** is a major barrier (across all the areas identified in earlier sections, but particularly in relation to vulnerable areas and options (from micro-finance upwards). It is also associated with a higher uptake of adaptation options more generally, i.e. it is a key enabling factor for building climate resilience.

A number of final issues are highlighted.

- These options increase productivity, so why aren't farmers already adopting them? In surveys in Ethiopia for example, only around half of farmers surveyed appear to be using them, due to various barriers such as the lack of information, money, labour, or land. Therefore the consideration of technical options alone is not sufficient – there is a need to address barriers to enhance the uptake of adaptation. Education, gender, age and wealth, as well as access to extension services and information on climate, are all correlated with the perceptions that the climate is already changing and with early adaptation. Dissemination of information (to raise farmers' awareness of the threats posed, and on changing crops and strategies) has also to be undertaken via both government and farmer to farmer extension.
- While some of the technical measures can be costed, it is often difficult to quantify many of these basic development options, and many of them have wider costs than the technical options alone. The World Bank (2011) found that identifying the cost of options was challenging. Many people did not know the costs of the strategies adopted, many strategies did not have direct costs (e.g. changes in consumption habits), or people were reluctant to disclose the costs. The analysis of the cost data found that it is difficult to give reliable

quantitative cost estimates and to give full insight into why households make these investments. Note that the costs of measures can also vary significantly.

- It is often even harder to quantify benefits. While there are literature studies for selected options in selected countries or regions, the variation in benefits is very large. In most cases, there are examples where low benefits arise, as well as classic development stories of new irrigation schemes that fail after a few years due to poor maintenance, lack of finance, etc.
- Most of these are already included in existing policy, e.g. in agricultural development programmes. In order to consider the potential for adaptation, it is necessary to consider what productivity levels are and which options are in place (and where).

Climate variability

The focus on current climate variability still involves a large overlap with standard development options, but at least it starts to provide a more explicit link to climate adaptation.

As highlighted above, there are still a large number of potential risks from the current climate in most LDCs for agriculture, and the range of crops, agricultural systems, types of climate risks can be large, and vary between and even within countries. However, it is clear that major risks arise to rain-fed small-scale subsistence farming, from variability and extremes.

An obvious response to current climate variability (as well as future changes) is to introduce different varieties (**crop switching**) more suited, i.e. more heat resistant and drought tolerant varieties or different species, or to **change planting dates** and systems. This can include using different varieties (e.g. less temperature sensitive maize), different crop mixes (e.g. a switch to cassava which has good resilience against variability) or shifting to short season crops to avoid extremes. However, there is often a general need for better yielding and more disease resistant varieties to increase productivity more generally, and that cope better with current climate variability. This option also links to R&D and crop selection development programmes, as well as protecting indigenous genetic resources.

Many of the adaptation options identified in country studies for agriculture are focused on **sustainable agricultural land management (SALM) practices**. These include for example, techniques to improve soil water infiltration and holding capacity, as well as nutrient supply and soil biodiversity. These therefore address underlying productivity issues, and in particular help with climate related risks in the form of rainfall variability and soil erosion from rainfall. There are also evidence that indicate that increasing temperature trends are increasing evapo-transpiration rates and heat stress to crops limiting their yield potential. The loss of soil fertility also leads to decline in soil organic matter content resulting in limited water holding capacity, poor water infiltration rate, limited availability of water and nutrients less resource use efficiency to crop plants. As well as addressing existing issues, and leading to productivity improvements, these options also therefore build resilience against future climate change. The costs of these measures have recently been reviewed in detail by McCarthy et al (2011), see below.

SALM includes options such as agroforestry, soil and water conservation, reduced or zero tillage, use of cover crops. Many of these overlap with the emerging focus on low carbon options for agriculture, i.e. climate smart agriculture. These options have the potential for increased productivity and food security, enhanced resilience, reduced carbon emissions.

Conservation agriculture includes a broad range of options, which minimize soil disturbance. It includes reducing or eliminating tillage using crop rotation (low or no/zero tillage or strip/zonal or ridge tillage), cover crops and using crop residues for mulching and soil cover, which reduces wind and soil erosion, increases water retention, and improves soil structure, thus increasing production, especially against a background of high climate variability. It also reduces GHG emissions and sequesters carbon (e.g. through residues).

Soil and water conservation (SWC) measures reduce soil erosion and retains moisture (controlling runoff), thus is beneficial for current climate variability and a largely no regret option for future climate change. These include a number of sub-categories

- Soil and water conservation structures, which include bunds, trees, grass strips, contour levelling, and terraces (stone, bench, contour), shade trees and waterways. There is already wide deployment of these measures in the highlands. These options also enhance soil carbon and are thus a climate smart option.
- There are also additional SWC climate smart options in the form of cover crops (planted post-harvest or intercropped), intercrops, improved fallows (legumes) and alley crops, which can improve soil and water conservation characteristics by keeping cropland covered during the entire year (reducing erosion and enhancing moisture), and for some options (legumes) increasing soil fertility. These also increase soil carbon, and are thus a climate smart option.
- There are also a wide number of water conservation measures (in addition to the soil and water conservation measures above). Examples include tied ridges (in situ water harvesting), small scale water-harvesting structures such as dams, ponds.

There are agro-ecological practices that contribute to soil and nutrient fertility enhancement (**soil management**) including residue and manure crop fertilization, agro-forestry, and efficient use of fertilizers, from low to higher tech solutions.

Agroforestry has the potential to increase organic matter, soil fertility, soil water holding capacity, improve the resilience of the soil and reduce soil erosion. It also reduces GHG emissions and can provide additional income. It provides many benefits in addressing current climate variability and future climate change, though there is a need to ensure the resilience of the tree species to future climate envelopes.

There are also a set of options that are often cited in relation to agriculture around **disaster risk management**. An obvious adaptation option – building on existing systems and strengthening monitoring and forecasting – are **early warning systems**, including the communication of information to end-users (including community based schemes, mobile sms applications, etc.). These provide a no regret option for current climate variability and provide resilience to climate change.

However, there are a large number of activities for disaster risk planning, ranging from capacity building and institutions, information, risk profiling, screening and mapping, emergency response planning (including rapid assessment and response), disaster prevention and risk reduction planning and financial contingency planning.

Similarly, there is the potential for **insurance** with options that range from micro-insurance through to weather index insurance. These provide an important response in spreading risks of current climate variability and also future resilience.

In the context of wider food security there are also the options of **safety nets and social protection programmes**, which provide income supplementation, often triggered in drought risk areas. These are often accompanied by **livelihood diversification and asset building / protection programmes**, i.e. to help vulnerable groups cope with climate variability and extremes.

Some issues are highlighted below.

- Some of these options are essentially good development options, even though they provide some benefits in relation to soil-moisture variables.

- Several of the most promising options provide largest benefits (i.e. they are most effective) when they are implemented as portfolios of actions, rather than as a single action. As an example, soil conservation, water harvesting technology and crop switching work best when implemented together. This is critical because improved crop species and varieties cannot deliver their full benefits unless issues of water stress, low soil fertility, pests and diseases, etc. are also addressed. Similarly, as new cultivars are generally more responsive to higher input use (such as water and fertilizer) there is the potential for greater cumulative increases in production when combined strategies are implemented.
- As above, many of these are already included in existing policy, e.g. under the sustainable land management programme (SLM):
- Many of these options have important opportunity or policy/transaction costs (see below). Furthermore, their benefits are often realised through long-term productivity gains through improved soil structure and the reduction in soil erosion. They therefore do not tend to perform as well under CBA as some conventional measures, or require lower discount rates to appear more attractive, or provide ancillary benefits (e.g. ecosystem service, wider livelihood benefits) that are not always easy to quantify.

| Cost category | Conservation agriculture | Cover crops and improved fallows | SWC structure | Agroforestry |
|------------------------|---|---|---|---|
| Investment | Machinery / implement costs. Availability of credit | Specialised planting implements | High up front financing, labour costs for construction | Up front financing |
| Variable / maintenance | Weed control costs | | Maintenance materials | |
| Opportunity | Family labour for weeding. Crop residues for feed/fuel. | Land for improved fallows | Household labour Land, as structure take some land out of production | Land and labour during establishment |
| Transactions | Access to information on management. Community rules on animal grazing post harvest. | Availability of local adapted seeds. Access of information. Community rules on animal grazing post harvest. | Access to information Collective action costs (where high benefits could be realised from collective action) | Lack of seedlings in market Access to information Community rules on burning. Collective action costs. |
| Risk | Risk of poor yield performance. Tenure insecurity. | Risk of reduced yield due to competition b/w cover and main crops | Risk of reduced yield in high rainfall years where structure built to conserve water Tenure insecurity | Risks of non-survival /poor performance Tenure insecurity |

Source: McCarthy et al (2011).

- The geographical applicability of the options varies, because of different climate risks. There are high differences in the measure that are applicable to different areas. As an example, IFPRI (2009) found that only waterways and trees show strong and significant positive effects in high-rainfall areas) highlighting spatial heterogeneity. In contrast, water management is a priority for the drylands. Soil management and conservation is important in all areas, but for different risk factors: the risks of water erosion in the highlands, and the wind-blown loss of soil in the drylands.

Capacity building

All of the issues above need to be seen against the background of institutional, capacity and governance. There are frequently major institutional and capacity gaps, including agro-

metrological information, management of key areas (e.g. watershed management), skill constraints, etc. Major institutional investments (and strengthening) are necessary. The low levels of adaptive capacity are an important issue in the successful uptake of any subsequent resilience plans. Lack of credit is cited as most significant barrier to adaptation in many studies (e.g. Nhemachena et al, 2010), but there are many factors that need to be addressed in terms of governance and institutional arrangements if adaptation is to be successful.

One major area (though it can also be defined as a response to climate variability) is better **climate information, research and enhanced co-ordination**.

This involves various capacity building programmes for climate change adaptation and also the potential for formal or informal networks or centre for co-ordination, including outreach and boundary organisations, though much of this may do with current climate information.

Improving the access to reliable climate forecast information is key to facilitating adaptation (Asfew et al, 2011), though a condition of this information being used in pro-active adaptation is that existing climate and seasonal forecasts are reliable, and the confidence in the information on future climate change (noting the very high uncertainty for the latter).

Another priority is for institutional strengthening and building. This includes a broad range of areas, but includes the potential for new or expanded research and institutions, including the architecture for climate change. Given the complex challenges faced, which span many disciplines, and the trans-regional nature, networking alliance and partnership can be established to help ensure more efficient use of resources, better public relations and resource mobilization. It also relates to the policy framework and governance: sound legal, institutional and policy frameworks at all levels are required to achieve climate smart agriculture, to create an enabling environment for farming and for climate-smart agricultural investments.

Meteorological and agro-metrological data, to ensure the communication of information through to farmers and communities, i.e. user orientated extension and communication outreach programmes. This includes data collection, monitoring and forecasting capability. Note this also extends to early warning systems, though these are included in a later section. A recent focus on the rapid transfer of information to community level in a timely manner, centres on SMS technology.

A further set of options are included around **agricultural research and development**. Putting in place the research programmes to develop the new seed varieties, to test promising options, to monitor changes, etc. There are a large number of R&D priorities which include new crop varieties (temperature and disease resistant, regional centres, testing of adaptation options and developing good practice, etc.

One aspect that comes up frequently is the need for **enhanced extension services**. This includes the communication of the issues above, but also the information from all the subsequent options, e.g. whether this is the use of different crop varieties or practice, etc. Expanding the mandate of existing institutional structures to include building adaptive capacity may be an effective means of reducing exposure to climate change, as in the case of agricultural extension services (Di Falco et al, 2011).

However, the key issue is that these options are the most challenging to appraise, because the options tend to be soft non-technical options, and include the capacity building, enabling and institutional issues: these do not lend themselves to a cost-benefit or even quantitative analysis.

Mainstreaming and enhanced resilience

These set of options are more policy orientated and align with the integration of climate change into existing development and sectoral policies. It can also look to build these aspects into new policies as they are developed, and to undertake climate risk screening to include resilience at the development stage, or as part of renewal or refresh programmes.

It therefore includes intuitional and capacity options, notably the consideration of climate risk screening tools (as developed by the multi-lateral development banks, such as World Bank and African Development Bank).

It may also involve specific options associated with sectors or areas.

An example would be the incorporation of enhanced resilience within current road building and strengthening programmes, or flood risk management plans, building in some extra design headroom (e.g. for greater flood volumes or resilience) to cope with future climate change.

However, such actions need to be treated with caution as they involve higher marginal capital costs. In some cases this maybe justified, e.g. where retrofit is difficult and lifetimes are long. In other cases it may not. As an example, the design lifetimes of roads is fairly low, thus there is little point in over-designing for the climate of 2050. What is of more concern are critical nodes, such as bridges, which tend to have a longer life-time, and are more important in relation access to market (as well as being potentially more at risk, e.g. from high flood flows).

For the agriculture sector, this generally involves the incorporation of climate change into sector policy, but the low levels of infrastructure do not require as much focus on climate risk screening, though irrigation and large scale water management especially, are possible exceptions.

There will also be some specific risk examples, such as low lying agricultural land in the context of sea level rise and inundation/salt water intrusion.

Long-term challenges

The focus of the long-term challenges involves a number of different issues.

All of these have the common theme that future climate change could be important, thus they include infrastructure with a long-life time, or future impacts that are not an issue now, but could be in the future.

It can include areas where current action involves long-life times, for example infrastructure that will be affected by future climate change. It can also include major effects that require early investigation or planning due to the time-scale involved, or the levels of risks and irreversibility involved. It might also include risks which involve thresholds, or irreversibility, which require a more precautionary based approach. Consideration of these longer-term issues may allow decision makers or planners to avoid future lock-in and prevent loss of future options. They may require early pro-active investigation (rather than early technical options) or initial short-term options that allow flexibility for the future.

Agriculture has relatively low levels of infrastructure with long life times, with the exception of large water storage projects.

There are, however, large risks in the future from major shift to agro-ecological zones for example, that might go beyond the limits of standard farm management options. Some of these require early action, as part of an iterative adaptive management framework. This generally has a focus on **early research and monitoring**, as part of these plans, along with scoping studies.

An example in the Ethiopia strategy was found for coffee. Coffee is the major export of the country, and the growth in exports is a key element of future growth plans. However, coffee is climate sensitive. Under high rates of climate change, by 2040, the critical threshold for current coffee production might be exceeded, moving current production areas from optimal to marginal productivity, or even making them unsuitable.

An iterative plan was developed, but some of the most promising options took time to develop. As an example, it would take time to develop, test and plant new varieties of Arabica coffee that are temperature resilient to the future scenarios. The problem is that there is not time to wait for the temperature change to occur before starting this strategy (the time taken from initial research

through development, piloting, scale-up, planting to maturation is 20 – 30 years). An adaptation pathway therefore identifies that an early priority would be start the initial research and development of such a programme now, recognizing this would be a relatively low cost option. If temperatures are observed to be rising rapidly, the programme can be accelerated and the new varieties rolled out. If temperatures are observed to be more modest, then an alternative lower cost option, such as shading, may be sufficient.

Analysis of Low-Regret Options for Agriculture

The discussion above highlights the issues in identifying and assessing low and no-regret options.

in generic terms, it has been fairly easy to identify a generic set of options that seem to be low- or no-regret in nature, though this includes around 40 or 50 options. It would be possible to provide information to help users identify these options and to highlight issues related to transferability, provide useful information sources and case studies, etc. However, even with this relatively small number of options, it would be difficult to provide a detailed decision tree that captured all the specific issues with each option.

An analysis of the literature and the options provides some important findings.

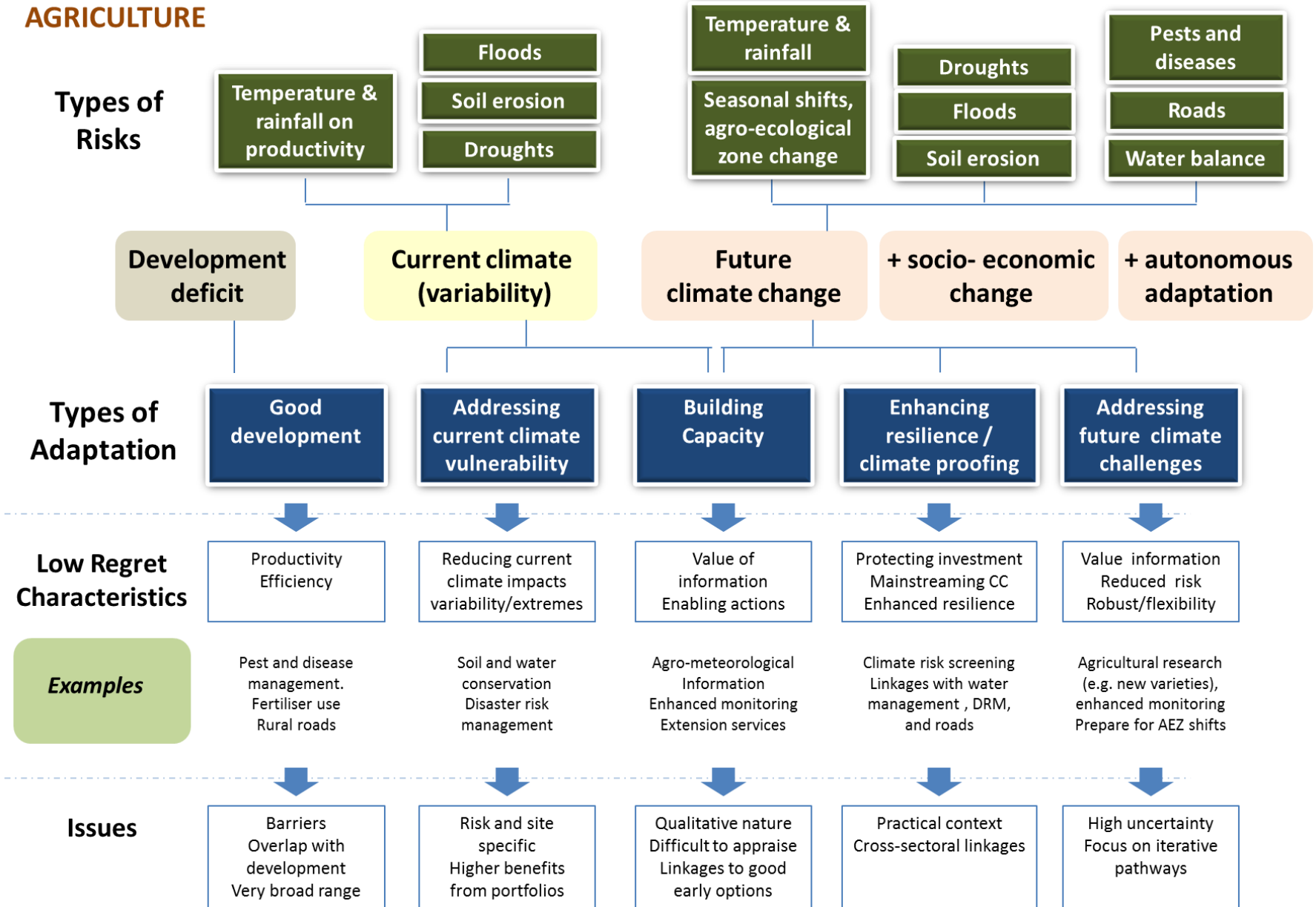
First, while some options fall distinctly into one category, a number potentially overlap. However, an important part of the typology concerns the information needed for appraisal of benefits, and for this reason, the typology does seem to work at the sectoral level.

Second, the detailed literature highlights that in many cases, options are more effective when implemented in combination (i.e. portfolios of options, such as combining improved seeds with soil and water conservation and better extension services). This is important for the subsequent toolkit, i.e. in highlighting that successful adaptation (and value for money) will require combinations of outcome and process based adaptation (and technical and socio-institutional interventions).

Third, it is fairly clear that options that address current climate variability are more risk and site specific, i.e. there are greater issues in the transferability of these options. Note that for agriculture, we have found less focus on the longer-term aspects, but this is because of the low levels of long lived infrastructure and fast adaptation response times.

Finally, some of the options have potentially high synergies with mitigation, e.g. climate-smart agriculture. It will be important to capture these synergies in the identification and prioritisation of options.

AGRICULTURE



Zanzibar Case Study

The study has applied the analysis to the case of a national action plan for Zanzibar, as part of the national climate change strategy development.

One of the objectives of the plan is to advance low and no-regret measures in five priority areas, one of which is in climate smart agriculture and natural resource management.

Agriculture is one of the key economic sectors for Zanzibar. It is also the main source of employment for the population, as well as an important economic sector for food production, employment generation, and exports.

There is some information on the current and future risks of climate/climate change to the agriculture sector, but the information is fairly limited, i.e. there is not detailed crop modelling.

However, it is fairly easy to identify risks based on the high proportion of rain-fed agriculture, the impacts of low rainfall years in the production statistics, and existing material.

A framework has been developed for the work that builds on the typology above and looks to apply strategy priorities around capacity building, identification of low and no-regret options, mainstreaming and long-term challenges, for focusing on climate-smart agriculture and related natural resource use.

The first main strategic priority is capacity building. There are a number of priorities to enhance sectoral resilience:

- Better meteorological and agro-metrological data, including data collection, monitoring and forecasting capability, but also early warning systems. A recent focus on the rapid transfer of information to community level in a timely manner, centres on SMS technology.
- Enhanced monitoring, particularly of pests and disease (crop and livestock), to track if shifts in climate are leading to changes in the prevalence or frequency.
- Agricultural research and development, notably around good practice, etc.
- Enhanced extension services, not least to raise awareness and communicate the suggestions below. Expanding the mandate of existing institutional structures (including extension services) to build adaptive capacity may be an effective means of reducing exposure to climate change.
- Enhanced early warning (covered in the first sector specific area), with a particular focus on the dissemination of useful information to farmers.

The second strategic priority is the identification of low or no regret options. A number of categories are included, with priorities of:

- General good agricultural development;
- Climate Smart Agriculture (sustainable agricultural land management) including conservation agriculture, soil and water conservation, agro-forestry.
- Rain water harvesting, as well as water efficiency and conservation.

There are some actions, which while not explicitly climate related, build on good practice (agricultural development) in the agricultural sector and are likely to have early benefits and build resilience. This includes agricultural techniques and management e.g. better seeds, more resilient and pest resistant crops, improved livestock (productivity, pest and disease resistance), better farm management practices, addressing post-harvest losses, etc. These improve yield

(low or no regret options) and may also be beneficial for emission, by increasing productivity or reducing losses, and thus reducing GHG emissions per unit of production.

One of the most promising areas identified is climate smart agriculture, which mostly builds on existing sustainable agricultural land management (SALM) practices (FAO 2011). These include techniques to improve soil water infiltration and holding capacity, as well as nutrient supply and soil biodiversity. These options improve productivity, and in particular help with climate related risks in the form of rainfall variability, and also build resilience against future climate change. They include options such as conservation agriculture (reduced or zero tillage, use of cover crops or crop residues, which increase water retention and improve soil structure), agroforestry (which increases soil fertility, water holding capacity, and reduces soil erosion), and soil and water conservation measures (structures or management practices). All these options also reduce carbon emissions, e.g. by minimizing soil disturbance and/or sequestering carbon. Many of these options have been tested on the islands, for example, a large proportion of areas already use some forms of agro-forestry, but there is potential for improvements.

A key priority is to develop the evidence base for these climate-smart agriculture measures, and to pilot these measures, complementing this with supporting awareness raising and extension support (see above).

Related to this is the issue of water management, to address rainfall variability and enhance production. One low regret option that was strongly recommended at the stakeholder workshops was the greater use of rain-water harvesting (RWH), and this option was also a priority area identified in the Zanzibar National Environmental Action Plan (2013). An obvious complementary no-regret option is for water conservation, leak reduction and efficiency improvements: this includes addressing the high leakage rates (systems, farm, households) but also the low efficiency of existing water use. Small-scale irrigation is also an option to increase productivity and reduce the impacts of climatic variability for agriculture.

The third strategic priority is mainstreaming. There are a number of key priorities

- Mainstreaming climate change into agricultural development plans. As an example, there have been recent proposals for relatively large irrigation developments on the islands, but these have not yet taken account of the potential changes from climate change. This can be addressed through climate risk screening, thus this is a priority. There is also a need to build climate change risks and opportunities into sector development plans.
- There is a clear mainstreaming priority around developing integrated water management, or integrated water resource management (IWRM).
- There is a similar mainstreaming priority around sustainable land-use management. While this includes some of the individual options above (e.g. SWC) it includes a strong focus on land ownership, reform, legislation and regulations.

The final strategic priority is for early actions to address longer-term challenges. A number of issues are highlighted.

A priority is for enhanced agricultural research to investigate the medium-long term challenges from climate change for agriculture, notably to understand which crops and varieties are more at risk, and to investigate and pilot responses, e.g. new varieties that are more resilient, switching to different crops.

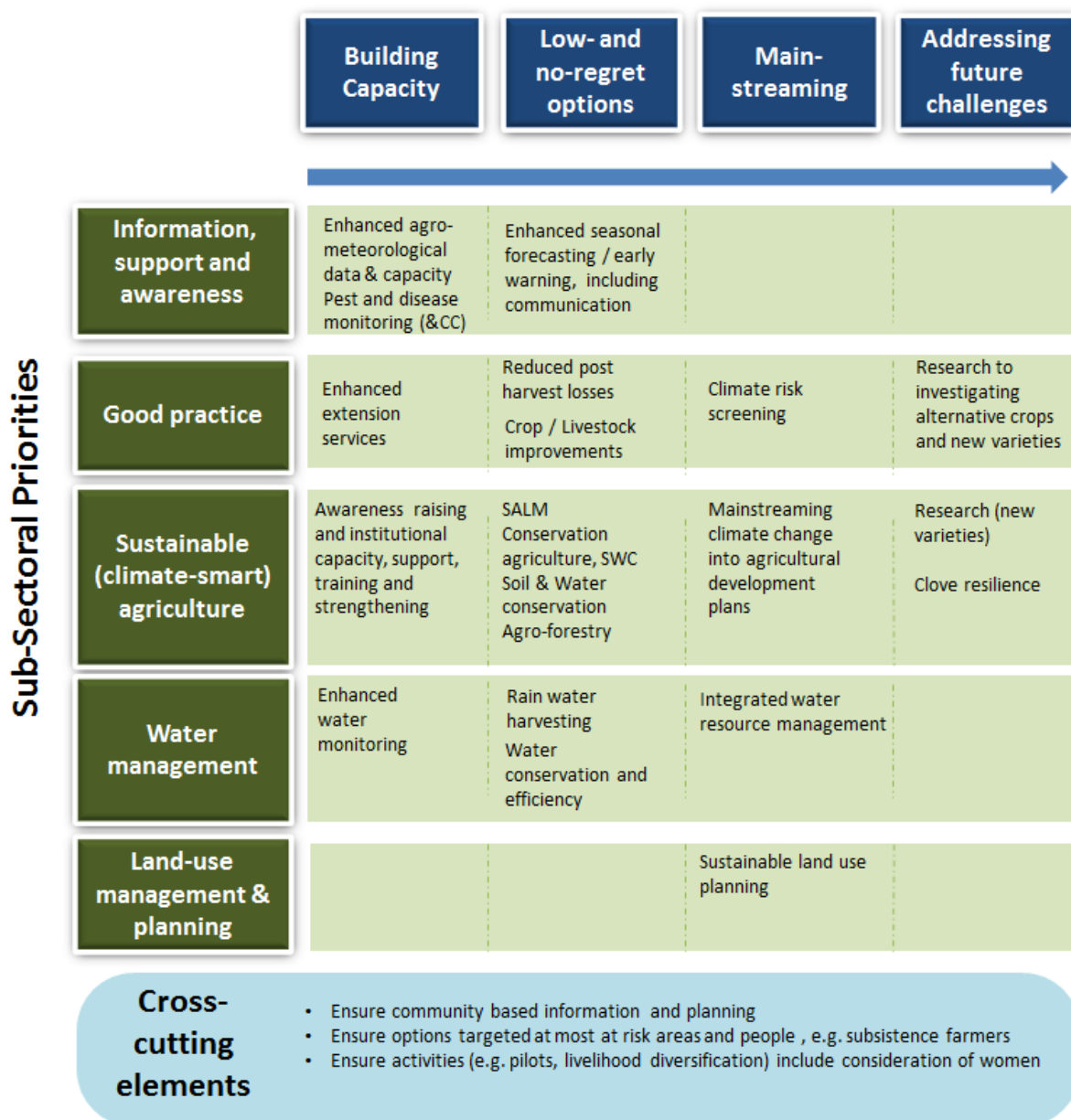
Another important issues is for cloves, as they dominate current exports, and are particularly important for Pemba. While current climate risks are considered relatively low, cloves are vulnerable to increased storm and high winds, and this could be a future issue given the observed data on strengthening wind regimes. There is therefore a need to ensure the resilience of production. This might involve short-term responses (pruning to reduce the loadbearing capacity), wind buffers, etc. An iterative plan is needed to start researching the issues, linking

this to observational data (e.g. whether wind speeds are increasing, and learning lessons (e.g. from Madagascar, where strengthening wind speeds is starting to affect production already). This does not require large-scale action, but it is important to start the early research and analysis.

A summary of the priorities is outlined below.

Climate Smart Agriculture and Natural Resource Management

Strategic Priorities (Adaptive Management)



This has highlighted some useful experience, from the perspective of using the approach and information needs:

- The typology is fairly logical to implement, and does help in filtering out more minor issues, i.e. it allows the focus on good early things to do (which would be consistent with VfM).
- There was not good information on risks, e.g. in terms of the current economic costs, or even the relative size of risks from current climate variability to the sector. There was even less information on future impacts of climate change. This position maybe better for some countries (e.g. due to NAPA, NAPs, National Communication) but there is likely to always be an issue of baseline risk information. The guidance probably needs to include information to help sources for risk identification.
- In some cases, there is quite a lot of technical knowledge needed in going from risks to matching specific adaptation options, e.g. in the consideration of soil and water conservation and the application to the specific local context.
- There is also quite a lot of local knowledge needed, in terms of contextual information and policy baseline. As an example, Zanzibar already has lots of informal agro-forestry, and the issues are around enhancing and improving this rather than introducing anew. Further, the ministry of agriculture is strong, and has preferred views on interventions, based around existing developing priorities (medium irrigation). At the same time there are already plans for rain water harvesting, thus there is the need to align with other policies.
- It is extremely difficult to find information that would allow a formal economic appraisal, or even a qualitative analysis of adaptation, because of the lack of benefit information (even for current variability)
- Finally, the study has tried to move to more specific action plans and log-frames, as per some of the examples in the other national strategies. The low and no regret options identified remain quite generic, and the move to more specific action and implementation plans will require a much greater level of detailed analysis.

Further analysis will be undertaken with the in-country case study visit.

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Tanzania

The **Tanzania National Climate Change Strategy**, published in 2013. It details strategic adaptation, mitigation and crosscutting interventions. The document states that it includes an action plan for the Strategy, and discusses generic costs to implement, but in reality this is a list of possible interventions and associated key actors.

It should be stressed that the overall Tanzania strategy is just a very long wish list, with over 200 individual interventions identified.

| | | |
|---|---|--|
| <p>Agriculture</p> <p>To enhance resilience of agriculture sector to climate change for sustainable livelihood.</p> | <p>a) To identify suitable crops for new agroecological zones. b) To promote appropriate agricultural practices that increase resilience to climate change. c) To promote use of appropriate technologies for production, processing, storage and distribution</p> | <p>a) Assessing crop vulnerability and suitability (cropping pattern) for different Agro-ecological zones b) Assess trade comparative advantage on traditional export crops with changing climate c) Promoting appropriate irrigation systems d) Promoting early maturing and drought tolerant crops e) Enhancing agro-infrastructural (input, output, marketing, storage) systems f) Promoting appropriate indigenous knowledge practices g) Development of crop insurance strategy. h) Strengthening weather forecast information sharing for farmers i) Strengthening post harvest processes and promote value addition j) Addressing soil and land degradation by promoting improved soil and land management practices/techniques. k) Strengthen integrated pest management techniques l) Promote use of pest/disease tolerant varieties m) Strengthen early warning systems for pest surveillance.</p> |
| <p>Research and development</p> | <p>a) To enhance coordinated research on climate change patterns; impacts; vulnerability; adaptation and mitigation options. b) To promote researches and development on technologies that will ensure sustainable response systems. c) To promote the implementation of research findings d) Development of new models for predicting the impacts of CC</p> | <p>a. Researching and promoting indigenous knowledge on adaptation and mitigation options b. Promoting research on sustainable and integrated natural resources management systems. d. Enhancing Research and Development of drought olerant, early-maturing and pest-resistant crop varieties and livestock; e. Promoting research on climate change related diseases, vectors and other health risks. f. Identifying and developing appropriate technologies for adaptation and mitigation. g. Developing new and making use of available models for predicting impacts of climate change and estimating adaptation and mitigation cost.</p> |
| <p>Capacity building and Institutional strengthening</p> | <p>a) To build institutional capacity to effectively address climate change issues b) To strengthen institutional coordination and inter-linkages.</p> | <p>a) Undertaking climate change institutional capacity needs assessment b) Developing and implementing a national capacity building programme on climate change c) Mobilising resources to support capacity building d) Strengthening national coordination, monitoring and evaluation systems e) Building the capacity of the government to undertake international and regional negotiations. f) Building the capacity of the government, civil society and the private sector on carbon credit and climate change financing. g) Establishing centres for coordinating climate change R&D activities</p> |
| <p>Systematic observation</p> | <p>a) To enhance surface and upper air observing networks b) To enhance capacity in remote sensing c) To enhance</p> | <p>a) Strengthening of weather radar network b) Improving existing and establishing new synoptic, agro-meteorological and climatologically stations to meet optimum observation c) Establishing marine stations d) Promoting documentation of indigenous knowledge. e) Enhancing data availability and modelling on climate change at all levels</p> |

| | | |
|------------------------------|---|--|
| | capacity in data base management d) To promote indigenous knowledge in weather forecast and climate prediction | f) Enhancing international cooperation in systematic observation |
| Early warning systems | a) To enhance early warning systems that respond to the challenges of climate variability and change b) To establish efficient mechanisms for packaging and dissemination of weather and climate information c) To promote advanced weather forecasting technologies. | a) Enhancing capacity in monitoring and prediction of extreme weather events and associated impacts b) Improving telecommunications for rapid and effective data and information exchange; c) Enhancing capacity to efficiently analyze and disseminate early warning information d) Enhancing documentation of relevant historical data e) Strengthening capacity in Numerical Weather Prediction and modeling f) Enhancing cooperation among relevant stakeholders and media, to ensure timely dissemination of products and information related to early warning g) Promoting regular review of appropriate technologies for effective functioning of early warning systems |
| Disaster and Risk management | a) To strengthen national capacity for disaster risks reduction and management b) To strengthen coordination and collaboration between diverse stakeholders in disaster management. c) To mainstream climate change into disaster risk management programmes. | a) Enhancing mechanisms for climate change related risks and vulnerability assessments b) Strengthening institutional arrangement for disaster and risk management c) Enhancing disaster preparedness and management at all levels d) Promoting technologies for management of climate change related disasters and risks. e) Establishing comprehensive community based early warning and disaster management systems f) Enforcing land use plans |

Rwanda

The Rwanda Green Growth and Climate Resilience (National Strategy for Climate Change and Low Carbon Development) was published in 2011. The overall framework is shown below.

Vision 2050: For Rwanda to be a developed climate-resilient, low-carbon economy by 2050.

Guiding Principles

Economic Growth and Poverty Reduction

Sustainability of the Environment and Natural resources

Welfare and Wellness of all citizens in a growing population

Good Regional and Global Citizenship

Gender Equality and Equity

Strategic Objectives

To achieve Energy Security and a Low Carbon Energy Supply that supports the development of Green Industry and Services

To achieve Sustainable Land Use and Water Resource Management that results in Food Security, appropriate Urban Development and preservation of Biodiversity and Ecosystem Services

To achieve Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change

Programmes of Action

Sustainable intensification of small-scale farming

Agricultural diversity of markets

Sustainable land use management

Integrated Water Resource Management

Low carbon energy grid

Small-scale energy access in rural areas

Disaster management and Disease prevention

Green industry and private sector development

Climate compatible mining

Resilient transport systems

Low carbon urban systems

Ecotourism, conservation and PES

Sustainable forestry, agroforestry and biomass

Climate data and projections

Enabling Pillars

Institutional Arrangements

Finance

Capacity Building and Knowledge Management

Technology, Innovation and Infrastructure

Integrated Planning and Data Management

Roadmap for Implementation

Big Wins, Quick Wins and Further Work

Integrating the Strategy into Vision 2020, EDPRS 2013-2017, sector strategies

Under the programmes of action, there are a number of agricultural and DRM related activities.

Programme 1: Sustainable Intensification of Agriculture

The sustainable intensification of agriculture is a key component in building a low carbon and climate resilient agricultural sector. Adaptation, mitigation and development options can be designed and implemented to counter the negative impacts from climate change and reduce the sector's dependency on fossil fuels. Small-scale agriculture can bring wider benefits associated with climate compatible development including food security, improved environmental sanitation, and disaster risk reduction through slope stabilisation and flood mitigation. Terracing and irrigation are already being implemented in Rwanda and will be extended throughout the country. In addition, to build resilience into agricultural ecosystems, Rwanda will

- Mainstream agroecology techniques using spatial plant stacking as in agroforestry, kitchen gardens, nutrient recycling, and water conservation to maximise sustainable food production;
- Utilise resource recovery and reuse through organic waste composting and wastewater irrigation;
- Use fertiliser enriched compost; and

- Mainstream sustainable pest management techniques to control plant parasites and pathogens.

Programme 2: Agricultural Diversity in Local and Export Markets

Rwanda will expand crop varieties, local markets and manufactured products and exports in support of the sustainable intensification and climate resilience of small-scale farming. This multi-faceted initiative will involve diversifying agricultural production and enhancing the agriculture value chain. Improving the agriculture value chain brings multiple benefits as it reduces dependency on external inputs (fertilizers/food/ fuel), reduces vulnerability to climate change and builds an agricultural market economy based on added value and import substitution. To become more self-sufficient Rwanda will

- Expand crop varieties for import substitution and climate resilience;
- Add value to those products through processing to meet its own market demand for food stuffs;
- Develop decentralised village-based agricultural processing centres that incorporate low-carbon sources of energy, such as biogas-digesters and solar driers; and
- Develop niche export crops under organic and fair-trade branding.

Programme 3: Integrated Water Resource Management and Planning

Rwanda is endowed with substantial freshwater resources. Regular rainfall patterns and minimal consumption has, until now, not necessitated water storage, water monitoring or irrigation infrastructure. There is a clear gap of observed data and monitoring frameworks for Rwanda's water and climate. The challenges of rapid population growth, increased urbanisation and industry, environmental degradation and pollution are leading to accelerated depletion and degradation of available water resources, while climate change is bringing uncertainty in future supply. In order to reverse this trend and ensure a sustainable water resource for socio-economic development, Rwanda will

- Establish a national integrated water resource management framework that incorporates district and community-based catchment management;
- Develop water resource models, improved meteorological services, water quality testing, and improved hydro-related information management; and
- Develop a National Water Security Plan to employ water storage and harvesting, water conservation practices, efficient irrigation, and other water efficient technologies.

Programme 4: Integrated Approach to Sustainable Land Use Planning and Management

Land tenure (ownership) security and a robust integrated framework for development planning and sustainable land management are essential for socio-economic development. With land tenure, owners have a responsibility to manage the land in accordance to planning codes, access to equity markets, and the economic incentive to improve the asset. As climate changes, land use may need to change, particularly agriculture. The National Land Use and Development Master Plan provides the platform for this new approach. With increasing and changing demands, Rwanda will

- Employ an integrated approach to planning and sustainable land use management;
- Improve its spatial data by harnessing ICT and GIS (Geographic Information System) technology; and
- Establish a National Information Sharing and Access Policy to guide management of this data.

Programme 12: Sustainable Forestry, Agroforestry and Biomass Energy

To meet energy demands for biomass it is necessary to ensure that supply meets or exceeds demand. Controlled tree planting through afforestation, reforestation, agroforestry and urban tree planting initiatives provides wood for fuel, improves slope stability supports food security and acts as a carbon sink, and can therefore earn carbon credits. To ensure sustainability of these initiatives, Rwanda will

- Promote afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes;
- Employ Improved Forest Management for degraded forest resources;

- Formulate a joint strategy for agroforestry between MINIRENA and MINAGRI;
- Mandate licensing of sustainable charcoal production techniques and promote improved cookstoves for efficient and clean wood and charcoal consumptions.

Programme 13: Disaster Management and Disease Prevention

Rwanda's hilly topography and high annual precipitation rates bring high risks from flooding, storms, landslides and vector and water-borne diseases, while other natural disasters include droughts and earthquakes. Over-exploitation of the natural environment such as deforestation and inappropriate farming on steep slopes increases the hazard risk, which may be exacerbated through climate change as an increase in extreme weather events occurs. To develop effective disaster management systems, Rwanda will

- Conduct risk assessments, vulnerability mapping and vector-borne disease surveillance;
- Establish an integrated early-warning system, and disaster response plans;
- Incorporate disaster and disease considerations into land-use, building and infrastructure regulations; and
- Employ community-based disaster risk reduction (DRR) programmes designed around local environmental and economic conditions, to mobilise local capacity in emergency response, and to reduce locally-specific hazards.

Programme 14: Climate Data and Projections

Robust observed climate data and climate projections for Rwanda are crucial to understanding the current and future impacts of climate change and developing scenarios to assess the potential adaptation strategies for Rwanda. The Rwanda Meteorological Service is executing its five-year Strategic Plan to upgrade its network of meteorological stations. In addition Rwanda will

- Arrange additional observations to provide all climate information necessary for future monitoring, climate trend detection, management of climate variability, early warning and disaster management;
- Establish a team to produce and interpret climate change projections for Rwanda, with a focus on disseminating climate model data in a user-friendly format for use by all stakeholders; and
- Develop the capacity in climate science necessary to underpin this work by incorporating climate science into secondary school and university curricula.
- Enhance the use of climate data in disease prevention and mitigation programmes for human health and agricultural crop productivity.

Quick wins

As part of the strategy, it identifies a number of 'quick wins'. These have the potential to represent low regret options. These immediate 'quick wins' begin to address the Enabling Pillars. They focus on mainstreaming climate resilience and low carbon development into initiatives that are currently underway.

1. Institutional Framework: Use the Integrated Development Programme (IDP) to facilitate implementation of climate resilient low carbon development in rural areas, incorporating the Vision 2020 Umurenge Programme. Sectors are already working together to improve development in rural areas and the Rural Development Task Force can be used to incorporate climate resilience into the IDP.
2. Finance: Operationalise the National Fund for Climate and Environment (FONERWA) to facilitate access to international climate finance, especially Fast Start Finance for adaptation. Capacity and finance will be required to make it operational and start channeling climate finance into implementation planning.
3. Integrated Planning and Data Management: Implement regular measuring and reporting of energy use across sectors to develop a GHG emissions profile and future energy requirements. More accurate knowledge of energy demands will enable better short and long term planning of energy resource management. This will also support applications for climate

finance which require that GHG emissions are Measurable, Reportable and Verifiable (MRV).

4. Capacity Building: Review and expand Technical and Vocational Educational and Training (TVET) to develop skills needed for the Strategy implementation. The Workforce Development Agency has proposed a TVET qualifications framework which will facilitate the development of new qualifications in areas such as renewable energy, agroforestry and irrigation.
5. Knowledge Management: Set up an online Climate Portal to communicate the National Strategy to the public and international community, thereby raising awareness and facilitating knowledge sharing. This has been done successfully by India and South Korea and is particularly important for adaptation as all Rwandans need to take steps to become climate resilient.
6. Technology: Use the Strategy to complete the UNEP Technology Needs Assessment already underway to speed up technology transfer for key sectors of the economy, particularly energy, water and agriculture.
7. Infrastructure: Implement resource efficient design in the Special Economic Zone (SEZ) in Kigali which is in the first stage of construction. This will include energy efficiency lighting, energy and water metering, wastewater recycling and recycling of other waste products. The SEZ guarantees reliable electricity supply to businesses, and this should be generated from renewable energy sources.

In addition there were five cross cutting pillars

There are also a number of cross cutting enabling pillars.

- Pillar 1: Institutional Arrangements. This includes the technical committee, but also a proposed Centre for Climate Knowledge for Development, and a National Fund for Climate and the Environment.
 - Priority 1. Establish new institutional arrangements, namely a Technical Coordinating Committee and a Centre for Climate Knowledge for Development
 - Priority 2. Mainstream the Strategy into Vision 2020, EDPRS II, and Sector policies and strategies
 - Priority 3. Mainstream the Strategy into sub-national institutional arrangements, and the Integrated Development Programme, and pilot 'climate smart' villages
 - Priority 4. Develop Local Adaptation Plans of Action and Locally Appropriate Mitigation Actions, and mainstream the Strategy into District Development Plans
 - Priority 5. Develop a common UNFCCC negotiating position with the EAC and LDC and Africa groups
- Pillar 2. Finance.
 - Priority 1. Operationalise the National Climate and Environment Fund of Rwanda, FONERWA
 - Priority 2. Secure grants from the Green Climate Fund, the Adaptation Fund and other climate funds targeted at LDCs
 - Priority 3. Promote CDM and voluntary carbon projects in Rwanda and push for simplified baseline calculations and monitoring methodologies at UNFCCC negotiations
 - Priority 4. Investigate and employ environmental fiscal reforms, a feed-in tariff, a green investment index, and public financing mechanisms to encourage green consumerism and investment
 - Priority 5. Encourage conservation through Payments for Ecosystem Services (PES) schemes
- Pillar 3. Capacity Building and Knowledge Management
 - Priority 1. Improve education by expanding school curricula, tertiary education, technical and vocational training and farmer field schools to address climate resilience and low carbon development
 - Priority 2. Develop capacity within national and sub-national government through exchange programmes, university partnerships, training focal points, professional development and pilot villages

- Priority 3. Improve knowledge management and public awareness through an online Climate Portal, creative radio programming, short training courses, demonstrations of best practice in communities and community exchange visits
- Priority 4. Engage in regional and international forums and partnerships on climate and sustainable development topics
- Priority 5. Ensure adequate education and training is provided for women and girls
- Pillar 4. Integrated Planning and Data Management.
 - Priority 1. Identify, record and maintain fundamental integrated data sets according to international standards, particularly for energy and water
 - Priority 2. Develop climate compatible national and district level sector plans integrated with national strategies based on the National Land Use and Development Master Plan
 - Priority 3. Develop a robust forecast of future resource demands and vulnerabilities which are stress tested for future shocks, with applicable warning indicators
 - Priority 4. Develop monitoring, reporting and evaluation systems to improve planning and provide the evidence base to receive climate finance
 - Priority 5. Improve spatial data by harnessing ICT and GIS (Geographic Information System) technology
- Pillar 5: Technology, Innovation and Infrastructure
 - Priority 1. Identify and implement applicable technologies through technology transfer to drive efficiency of resource consumption and creation, particularly in energy and water
 - Priority 2. Perform local research and development of applicable technologies for climate resilience and low carbon development, particularly for agriculture
 - Priority 3. Invest in relevant climate resilient infrastructural projects, particularly an all-weather road network and irrigation
 - Priority 4. Develop links to regional and international centres of excellence to benefit from the latest research on climate resilience and low carbon development

For each programme, an analysis was undertaken, e.g. for sustainable intensification of agriculture.

Key Indicators

| | |
|---|---|
| Action 1: Mainstreaming of Agroecology | <i>% of farms up-taking agroecology technologies</i> |
| Action 2: Resource Recovery and Reuse | <i>Volume of waste reduction / Compost production</i> |
| Action 3: Fertiliser Enriched Compost | <i>% of farms applying fertiliser rich compost</i> |
| Action 4: Mainstreaming of "Push-Pull" Strategies | <i>% of farms up-taking "push-pull" strategies</i> |

Comparative Cost

| | | | |
|---|-----|--------|------|
| Action 1: Mainstreaming of Agroecology | Low | Medium | High |
| Action 2: Resource Recovery and Reuse | Low | Medium | High |
| Action 3: Fertiliser Enriched Compost | Low | Medium | High |
| Action 4: Mainstreaming of "Push-Pull" Strategies | Low | Medium | High |

Emissions Reduction

| | | | |
|---|------|--------|-----|
| Action 1: Mainstreaming of Agroecology | High | Medium | Low |
| Action 2: Resource Recovery and Reuse | High | Medium | Low |
| Action 3: Fertiliser Enriched Compost | High | Medium | Low |
| Action 4: Mainstreaming of "Push-Pull" Strategies | High | Medium | Low |

Climate Resilience

| | | | |
|---|------|--------|-----|
| Action 1: Mainstreaming of Agroecology | High | Medium | Low |
| Action 2: Resource Recovery and Reuse | High | Medium | Low |
| Action 3: Fertiliser Enriched Compost | High | Medium | Low |
| Action 4: Mainstreaming of "Push-Pull" Strategies | High | Medium | Low |

Timescale to Initiation

| | | | | |
|---|-----------|-------|--------|------|
| Action 1: Mainstreaming of Agroecology | Immediate | Short | Medium | Long |
| Action 2: Resource Recovery and Reuse | Immediate | Short | Medium | Long |
| Action 3: Fertiliser Enriched Compost | Immediate | Short | Medium | Long |
| Action 4: Mainstreaming of "Push-Pull" Strategies | Immediate | Short | Medium | Long |

Programme Length

| | |
|---|--|
| Action 1: Mainstreaming of Agroecology | <i>Ongoing</i> |
| Action 2: Resource Recovery and Reuse | <i>3 year initiation and development</i> |
| Action 3: Fertiliser Enriched Compost | <i>Ongoing</i> |
| Action 4: Mainstreaming of "Push-Pull" Strategies | <i>Ongoing</i> |

Climate Finance Streams

Adaptation Fund - Africa Enterprise Challenge Fund - ClimDev-Africa Special Fund - EIB Post-2012 Carbon Credit Fund - EIB-KfW Carbon Programme II - Global Climate Change Alliance - Global Environmental Facility - Global Facility for Disaster Risk Reduction and Recovery - Hatoyama Initiative - International Climate Initiative - International Climate Fund - International Development Association - KfW Development & Climate Finance - Least Developed Country Fund - Nordic Climate Facility - Public-Private Infrastructure Advisory Facility - Special Climate Change Fund - UNDP Green Commodities Facility - UNDP/MDG Carbon Facility - World Bank Carbon Facility - World Bank Catastrophe Risk Management Facility - Clean Development Mechanism - Voluntary Carbon Markets

Agricultural Diversity in Local and Export Markets

Key Indicators

| | |
|--|---|
| Action 1: Expansion of Crop Varieties | <i>% of farms adopting crops</i> |
| Action 2: Expansion of Local Markets | <i>No. of markets constructed/national product flows</i> |
| Action 3: Expansion of Manufactured Products | <i>% of districts with product manufacturing capacity</i> |
| Action 4: Expansion of Exports | <i>% of agricultural production of niche export crops</i> |

Comparative Cost

| | | | |
|--|-----|--------|------|
| Action 1: Expansion of Crop Varieties | Low | Medium | High |
| Action 2: Expansion of Local Markets | Low | Medium | High |
| Action 3: Expansion of Manufactured Products | Low | Medium | High |
| Action 4: Expansion of Exports | Low | Medium | High |

Emissions Reduction

| | | | |
|--|------|--------|-----|
| Action 1: Expansion of Crop Varieties | High | Medium | Low |
| Action 2: Expansion of Local Markets | High | Medium | Low |
| Action 3: Expansion of Manufactured Products | High | Medium | Low |
| Action 4: Expansion of Exports | High | Medium | Low |

Climate Resilience

| | | | |
|--|------|--------|-----|
| Action 1: Expansion of Crop Varieties | High | Medium | Low |
| Action 2: Expansion of Local Markets | High | Medium | Low |
| Action 3: Expansion of Manufactured Products | High | Medium | Low |
| Action 4: Expansion of Exports | High | Medium | Low |

Timescale to Initiation

| | | | | |
|--|-----------|-------|--------|------|
| Action 1: Expansion of Crop Varieties | Immediate | Short | Medium | Long |
| Action 2: Expansion of Local Markets | Immediate | Short | Medium | Long |
| Action 3: Expansion of Manufactured Products | Immediate | Short | Medium | Long |
| Action 4: Expansion of Exports | Immediate | Short | Medium | Long |

Programme Length

| | |
|--|----------------|
| Action 1: Expansion of Crop Varieties | <i>Ongoing</i> |
| Action 2: Expansion of Local Markets | <i>Ongoing</i> |
| Action 3: Expansion of Manufactured Products | <i>Ongoing</i> |
| Action 4: Expansion of Exports | <i>Ongoing</i> |

Climate Finance Streams

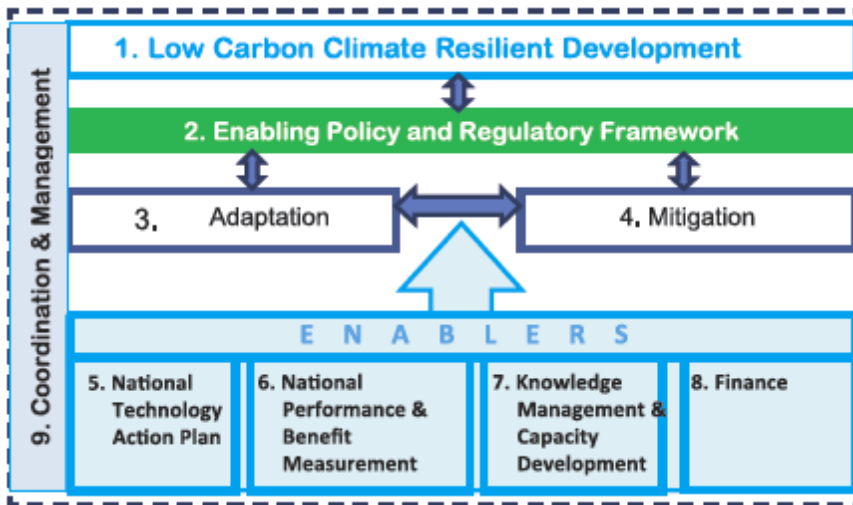
Adaptation Fund - Africa Enterprise Challenge Fund - ClimDev Africa Special Fund - DEG – Deutsche Investitions - Global Climate Change Alliance - Global Environmental Facility - Hatoyama Initiative - International Climate Initiative - International Climate Fund - International Development Association - KfW Development & Climate Finance - Least Developed Country Fund - Nordic Climate Facility - Public-Private Infrastructure Advisory Facility - Special Climate Change Fund - UNDP Green Commodities Facility

Kenya

The **Kenya National Climate Change Action Plan 2013-2017** was developed with the aim of implementing the National Climate Change Response Strategy (NCCRS). It provides the analysis and enabling mechanisms to make a step change in progress.

The NCCAP sets out a vision for a low carbon climate resilient development pathway; summarises analysis of mitigation and adaptation options and recommended actions; recommends an enabling policy and regulatory framework; and sets out next steps for knowledge management and capacity development, technology requirements, a financial mechanism, and a national performance and benefit measurement system (NPBM).

The components on the action plan are shown below, and the plan is built around the 8 sub-components shown.



The NCCAP provides full details of a range of adaptation and mitigation actions in the context of a low carbon climate resilient development pathway.

The big wins identified will make a significant impact on sustainable socio-economic development, adaptation and mitigation in Kenya. They include:

- Geothermal power generation
- Distributed clean energy solutions
- Improved water resource management
- Restoration of forests on degraded lands
- Climate smart agriculture and agroforestry
- Infrastructure

There are also priorities at a sectoral level. As an example, for agriculture:

- Agroforestry. This has the potential to abate 4.2 Mt CO₂e by 2030, while offering climate resilience benefits of improved food security, soil quality, improved soil water retention, reduced erosion, and perennials that are better able to withstand climatic changes.
- Conservation tillage and limiting the use of fire in cropland and rangeland management has the potential to abate 1.1 and 1.2 Mt CO₂e by 2030, respectively.
- Actions to support climate change adaptation in the highly vulnerable yet naturally resilient Arid and Semi-Arid Lands (ASALs) include improved management of grazing systems, livestock diversification, and breeding techniques as well as the provision of accessible climate information to farmers and pastoralists.
- Other actions including promotion of drought tolerant crops, water harvesting, integrated soil fertility management, insurance schemes, price stabilisation schemes for livestock, strategic food reserves, and mainstreaming climate change into agricultural extension services.

The plan provides cost estimates. While not quite at the level of detail of an investment plan, there are detailed estimates for each area, which are then aggregated as below.

Total costs for next five years (2013 -2017) associated with Kenya's NCCAP

| Total Costs of Kenya's NCCAP | Ksh | USD |
|---|---------------------|----------------------|
| Projected investment costs for mitigation actions for next five years (Table 12.4 in NCCAP) | Billion 494 – 391 | Billion 5.8 – 4.6 |
| Projected adaptation costs for next five years in key sector (Table 12.5 in NCCAP) | Billion 638 | Billion 7.5 |
| Costs associated with administration and process actions for next (five years) (Table 12.6 in NCCAP) | Billion -5.3 5.0 | Million 59-62.3 |
| Estimated Investment Range | 1137.3 – 1034 | Billion 13.4 – 12.2 |
| Total Estimated Investment Required 2013-2017 average of above range) | Billion 1085 | Billion 12.76 |

It is stressed that at US\$13 billion, the costs of the plan are extraordinarily large – even with respect of global adaptation flows (administration costs alone are estimated at \$60 million).

Economic Pillar/ Agriculture, Livestock and Fishing/ Agriculture – Pathwa and Factsheet

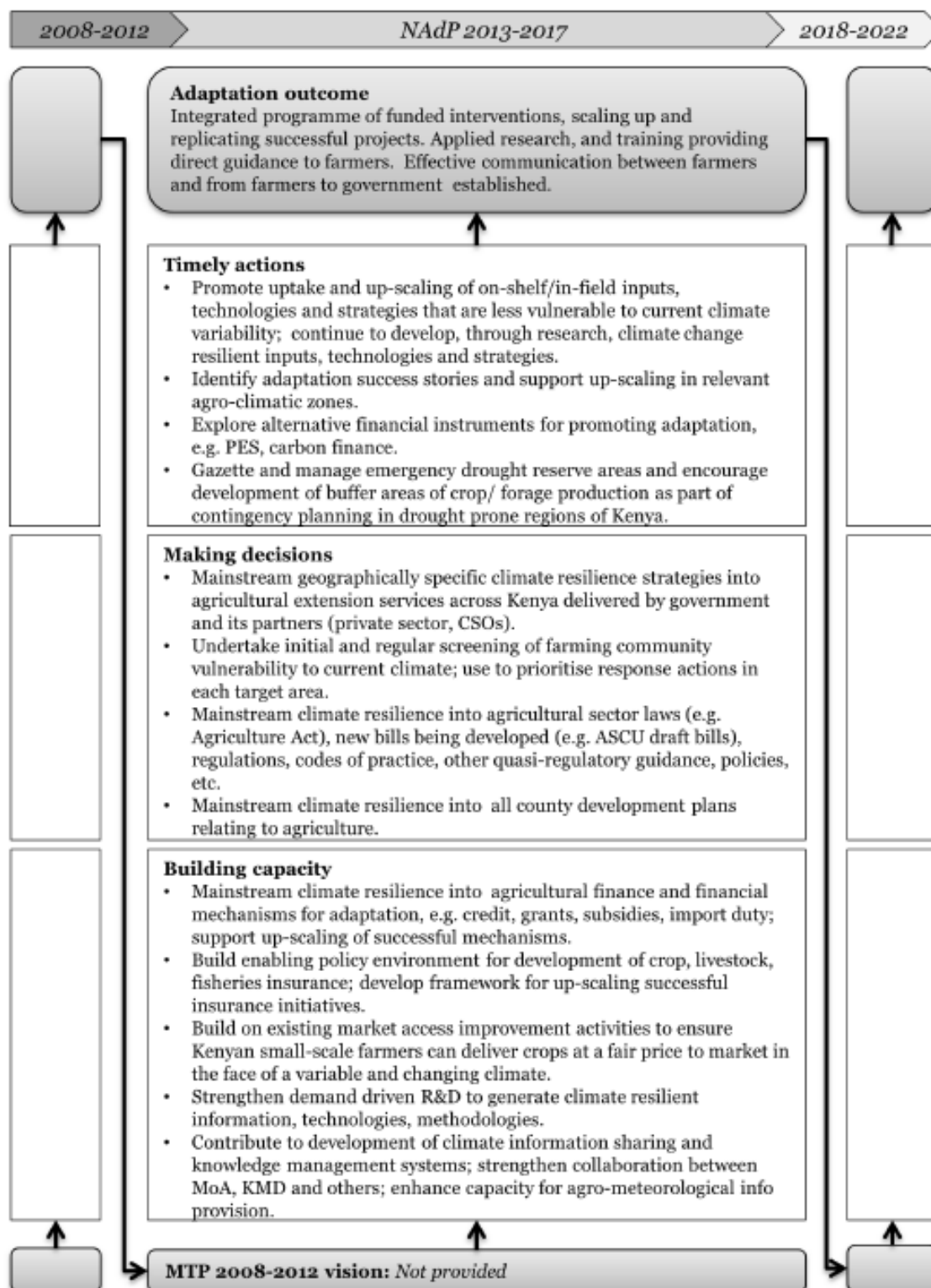


Figure 8.13. Resilience pathway for Agriculture theme

Table 8.16. Adaptation actions factsheet for Agriculture theme

| | |
|---|---|
| Priority adaptation actions for Agriculture | Factsheet reference number: SC3_1.1 |
| <p>Action summary The production of food crops, industrial crops and horticultural products is a key component of the Kenyan economy, supporting small-scale subsistence farmers, contributing to food security and delivering foreign exchange earnings. The agricultural sector, however, is very climate sensitive and is negatively affected by current climate variability (e.g. drought, flooding, erratic and intense rainfall), leading to reduced productivity and insecure livelihoods. Negative impacts are also projected under future climate scenarios for many parts of the county, while some agricultural areas and products are projected to improve. While action is already being taken to build resilience by government, Kenyan farmers and other stakeholders (see NAdP database, County Consultation outputs), livelihoods are still being negatively affected. More action and support is therefore required to achieve Kenya's development goals, build a resilient sector and take advantage of climatic opportunities where they arise. A range of potential actions have been identified for the Agriculture theme over the next 5 years, and are detailed in the adaptation action 'long lists' presented in Appendix 2. Priority actions proposed for GoK to roll out and support the desired adaptation outcome for 2017 are presented in the Agriculture resilience pathway (Figure 8.13). Further information on this factsheet relates to priority adaptation actions specifically.</p> | |
| <p>Areas of relevance GoK planning sector: 1.1 Agriculture (crop-related) MTP theme: Economic pillar: Agriculture, livestock and fishing. Geographic region: National For all actions: Adaptation <input checked="" type="checkbox"/> Development <input checked="" type="checkbox"/> For some actions: Mitigation <input checked="" type="checkbox"/> Ecosystem-based <input checked="" type="checkbox"/></p> | |
| <p>Current status Many autonomous and planned adaptation activities are already underway across Kenya, at national and community level.</p> | |
| <p>Lead Agency to take actions forward At the national government level, the Ministry of Agriculture (MoA) is requested to lead on delivering sectoral actions.</p> | |
| <p>Stakeholder support required to take actions forward A range of supporting actors are required to deliver the various priority Agriculture adaptation actions. These include national level cross-ministerial organisations (i.e. the Agricultural Sector Coordination Unit), other line Ministries (e.g. Ministry of Development of Northern Kenya & Arid Lands, Ministry of Cooperative Development & Marketing, Ministry of Higher Education, Science & Technology, Ministry of Special Programmes, Ministry of Trade, Ministry of Regional Development Authorities), others government bodies (e.g. the Agricultural Finance Corporation, the Kenya Agricultural Research Institute), the private sector, NGOs, CSOs and communities. Specific stakeholders should be identified for each individual action.</p> | |
| <p>Indicative timeframe Launch timeframe: short-term, within next 5 years (the 2013-2017 MTP period). Duration of the actions: short, medium and long term; annual and 5-year reviews should be conducted to monitor success of existing projects, ensure improvements where necessary and agree priorities for next 5 year period. Quick win opportunity for many priority actions <input checked="" type="checkbox"/></p> | |
| <p>Cost associated with the Actions in Kenyan Shillings Indicative cost (NCCRS, 2010): Ksh 10.6 billion.⁵ This estimate does not cover all priority actions in this sector. It is therefore likely that actual costs will be higher. A full sectoral appraisal of Investment & Financial Flows is required.</p> | |
| <p>Immediate next steps (within 6 months of KCCAP endorsement) (1) MoA to do final review and approve post-validation Agriculture ATAR adaptation actions; (2) MoA to meet with NAdP coordinating body (see SC2 output) to agree approach for delivering Agriculture ATAR actions; (3) MoA to meet with Ministry of Planning MTP review and T21 teams to agree integration of Agriculture adaptation activities in MTP 2013-2017; (4) MoA to identify key stakeholders and commence delivery of actions in partnership.</p> | |

Fiji

The **National Climate Change Adaptation Strategy(NCCAS) for Land Based Resources - Government of Fiji** lays out an approach to identify and implement efficient and effective activities to manage the existing and anticipated consequences of climate change for the land-based resources sectors in Fiji, namely, agriculture, biodiversity, forestry, land and water.

The document is in 2 parts.

Part 1 is the National Climate Change Adaptation Strategy. This section is a high-level national document that focuses on the cross-sectoral issues of adaptation.

Part 2 is the **Sector Adaptation Action Plans**.

This section covers specific adaptation actions plans for the agriculture, forestry, water, environment and land sector that define the following:

- Adaptation Measures = the main adaptation action to be implemented
- Adaptation Actions = the supporting actions that lead to the implementation of the main adaptation action
- Key Actors = the leading actor responsible for the implementation of the adaptation action
- Partners = additional actors who cooperate with the key actor during the implementation of the adaptation action
- Financial Input = the financial input required to implement the adaptation action
- Planned Output = the desired output of the adaptation action
- Key Performance Indicator = a specific measure to assess the performance of the adaptation action
- Timing = the deadline for achieving the planned output

Agricultural sector plan

| Measure | Action | Key Actors | Partners | Financial Input ¹⁶ | Planned Outputs | Key Performance Indicator(s) | Timing |
|---|---|---------------|--|-------------------------------|---|--|-----------|
| 1. Improve and expand sustainable farming methods | a) Identification of appropriate farming practices suitable for specific soil types | MPI (DoA) | NGOs, Communities, SRIF, NGOs, Private Sector | Medium | -Report | -# of identified farming practices | 2012-2013 |
| | b) Train extension services and communities in integrated farming systems (e.g. contour farming, minimum tillage, cover vegetation, crop rotation) to diversify crop cultivation, enhance soil fertility, pest and weed control (e.g. marigold) | MPI (DOA/DoF) | NGOs, DoE, MoE, Health, Communities, SRIF, NGOs, Private Sector | Medium | -Trainings | -# of trained extension services and communities | 2012-2017 |
| | c) Upscale the use of low-cost organic fertilizers (e.g. use of organic manure) | MPI (DOA) | NGOs; Private Sector; Organic Farmer's Association; Sugar Cane Research Institute Fiji | Low | -Trainings -Farmer-to farmer visits | -# of trainings and farmer-to-farmer visits | 2012-2021 |
| | d) Improve land arability (e.g. by agroforestry, afforestation) in rural areas | MPI (DOA) | Min of Provincial Development; Land Use; Regional Organisations (eg. SPC) | Medium - high | -Afforestation | -ha of trees planted | 2012-2013 |
| | e) Improve the documentation of farming systems | MPI (DOA) | Min of Provincial Development; Land Use; Regional Organisations (eg. SPC) | Medium - high | -adopted and documented farming systems | -Reports | 2013-2021 |

| Measure | Action | Key Actors | Partners | Financial Input ¹⁸ | Planned Outputs | Key Performance Indicator(s) | Timing |
|---|--|--------------------------------|---|-------------------------------|---|---|-----------|
| 2. Protect agricultural land by conserving adjacent ecosystems | a) Improve coastal protection (e.g. mangrove and coastal forest planting) | MPI (DoF/DoA). | Min. of Lands, Min of Provincial Development, Academic Institutions, NGOs, Min of Education, DoE, Communities | Medium - high | -Replanting | -ha of trees planted | 2012-2021 |
| | b) Increase/introduce foreshore protection with stones or rocks in coastal communities | MPI (DoF/DoA). | Min. of Lands, Min of Provincial Development, Academic Institutions, NGOs, Min of Education, DoE, Communities | High | -Foreshore protection | -# of coastal communities with foreshore protection | 2012-2021 |
| | c) Conserve mangroves wherever existing adjacent to arable land | Min of Provincial Dev. | NGOs, Local and Urban Planning, Communities, Academic Institutions, DoE, MPI, Itaukei Affairs | Medium | -Conserved mangroves | -Conservation plans | 2012-2021 |
| | d) Establish and maintain more fire&wind breaks (e.g. bare strips, hedges, trees)esp. in dry areas | MPI (DoF) | NGOs, Communities | Medium - high | -Fire & wind breaks | -# of fire and wind breaks | 2012-2021 |
| 3. Conserve water and increase water efficiency for agriculture | a) Assessment and protection of existing water sources | Min of Mineral Resources (MRD) | MPI (DoF), WAF, NGOs | Medium | -Water assessment | -# of water assessments | 2012-2021 |
| | b) Apply and upscale good agronomic practices for water conservation (e.g. mulching) | MPI (DoA) | NGOs, Communities, primary and secondary schools | Low - medium | -Trainings in water conservation technologies | -#of farmers practicing water conservation | 2013-2021 |
| | c) Improve and maintain water drainage systems (example PACC project) | MPI (DoA) | Communities | Medium - high | -Improved drainage systems | -# of improved drainage systems | 2013-2021 |
| | d) Improve and upscale (low cost) irrigation systems | MPI (DoA) | Private Sector | Low High | -Trainings -Irrigation systems | -# of trainings -# of irrigation systems | 2013-2021 |

| Measure | Action | Key Actors | Partners | Financial Input ¹⁸ | Planned Outputs | Key Performance Indicator(s) | Timing |
|---|---|---------------------------|--|-------------------------------|--|--|-----------|
| | e) Establishment of additional water-shed areas under IWRM | MPI (DoA/DoF) | WAF/DWS, CCU, DoE, NGOs, Donors, MTA, Communities, Councils, Local Govt, DoA, TAB, SPC | Medium - high | -additional watershed areas under IWRM | -# of water-shed areas under IWRM | 2013-2021 |
| 4. Integrate CCA&DRR into agriculture (management & research) | a) Promote plant breeding of heat, drought, flood and salt resistant varieties and cultivars (e.g. early maturity crops, shorter varieties) | MPI (DoA) | Academic Institutions, SPC, Communities | Medium | -In-situ & Ex-situ cultivation | -# of varieties and cultivars | 2013-2021 |
| | b) Promote the selection of healthy planting material and planting of heat, drought, flood and salt resistant varieties and cultivars and establish nurseries | MPI (DoA) | Academic Institutions; Farmers, SPC, NGOs, Itaukei Affairs, Biosecurity | Medium | -nurseries -Planting climate proof crop varieties and cultivars | -# of nurseries -# of planted crop varieties and cultivars -# of new areas | 2012-2021 |
| | c) Relocation of agricultural research plots from floodplain to other areas | MPI (DoA) | Academic Institutions; Ministry of Lands | Medium - high | -New research plots | -# of research plots outside the floodplain | 2012-2014 |
| | d) Move agriculture farmland from coastal zones and floodplains to the further inland | TLTB | MTA, MPI, Provincial Dev., | High | -New agricultural farmland | -# of ha farmland in the further inland | 2013-2021 |
| | e) Increase use of hydroponics | MPI (DoA) | MTA, Private Sector | Medium - high | -Trainings -Establishment of hydroponics | -# of hydroponics used | 2013-2016 |
| | f) Promote aquaculture as an additional source for food and income | MPI (DoA) | Academic Institutions | Medium - high | -Established aquaculture systems | -# of aquaculture systems | 2013-2018 |
| | g) Improve monitoring and surveillance of invasive species through on-site visits (and border control) | Biosecurity of Fiji (BAF) | MPI, NGOs, Communities | Medium - high | -Improved monitoring & surveillance system | -# of on-site visits | 2013-2021 |
| | h) Assess the potential of agricultural micro-insurances to compensate for losses caused by natural disasters | MPI (DoA) | CCU, NGOs, Donors | Medium | -Assessment report | - report | 2012-2013 |

| Measure | Action | Key Actors | Partners | Financial Input ¹⁶ | Planned Outputs | Key Performance Indicator(s) | Timing |
|---|---|--|---|-------------------------------------|--|---|-----------|
| 5. Improve CCA&DRR awareness and dissemination of information and knowledge | i) Establishment of plastic houses (e.g. for vegetables) | | Private sectors, communities | Medium | Established plastic houses | -# of plastic houses established | 2013-2016 |
| | a) Use existing extension meetings to exchange information and knowledge with farmers and to raise awareness (use of media e.g. radio, television) in the vernacular | MPI (DoA) | Min of Education, Min of Itaukei Affairs | Medium | -CCA&DRR integrated in extension meetings | -# of extension meetings | 2012-2021 |
| | b) Improve awareness and reporting mechanisms on various climate and disaster impacts such as floods, fire risks, invasive species, pest & diseases, etc. by building on existing participatory tools | MPI (DoA) | NDMO, NGOs, DoE, Communities FMS, Min of Education (MoE) | Medium | -CCA&DRR integrated in participatory awareness tools -Reports | -# of reports disseminated | 2012-2021 |
| | c) Improve the access to seasonal weather forecast system by information and communication technology (ICT) (in the vernacular) | FMS | MPI, Academic Institutions, NGOs, Private Sector | Medium-high | -Improved access to seasonal weather forecast system | -# of communities using ICT | 2013-2015 |
| | d) Development of rural and maritime information centres for collection and dissemination of information | MPI (DoA) | Min of Education, Min of Itaukei Affairs | Medium | -Rural information centres | -# of rural and maritime information centres | 2013-2018 |
| e) Strengthen linkage between research information with extension officers | MPI (DoA) | Min of Education, Min of Itaukei Affairs | Medium | -better informed extension officers | -# of farmers adopting new technologies | 2013-2018 | |
| 6. Improve food processing, preservation and marketing | a) Improve the crop marketing system by appropriate implementation standards | MPI (DoA), GOF | Private Sector, SPC, regional projects | High | -Identified rural collection centres | -# of rural collection centres adopting the standards | 2013-2018 |
| | b) Improve transportation to markets (to reduce post-harvest loss) | MPD | MPI, Itaukei Affairs, Min of Transport, Provincial Devt | Medium-high | -Improved transportation systems | -% reduction of harvest loss | 2013-2018 |
| 7. Integrate CCA&DRR issues into national codes | c) Improve crop preservation and processing by upscaling traditional methods and introducing new technologies d) Improve food processing standards e) Introduction of value-added products | MPI | Private Sector; Academic Institutions; SPC, Min of Health | Medium | -Trainings in crop preservation and processing | -# of trainings -# of communities practicing improved crop preservation and processing -# adopted new standards -# of value-added products | 2013-2018 |
| | a) Introduce building codes for a climate&disaster proof infrastructure (e.g. sugar cane tram line system) | Govt of Fiji | Fiji Institute of Engineers, FSC | Low-medium | -Updated building codes | -# of infrastructure constructed under the updated building code | 2012-2017 |
| | b) Integrate CCA issues into the National Code of Planting and Harvesting Practice c) Integrate CCA issues into CODEX | MPI CODEX Committee (MPI, MTC) | Communities, Private Sector, Regional organisation | Low-medium | -Updated planting and harvesting codes | -updated code | 2012-2017 |

There are also sector adaptation matrices

Agriculture Sector

| Exposure Unit | Action | Addressing the following impacts | Community focused (Y/N) | Specific Adaptation Benefits / Higher Resilience due to... | Source Document | Action # |
|-----------------|---|---|-------------------------|--|-----------------|--------------------------|
| Crop Production | 1. Construct nurseries and establish seed stores. | Cyclones/ Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> Increased food security | DRM | Activity 1.6.2 |
| | 2. Development of improved irrigation systems for Taro (dalo) production | Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> Higher crop and vegetation resilience Increased food security | INC PFST | Action 6.2.3 Step 3 & 11 |
| | 3. Promote appropriate irrigation of sugar-cane production on better lands | Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> Higher crop and vegetation resilience | INC NSAP | Action 6.2.3 Action 8.2 |
| | 4. Conduct upgrades and or appropriate maintenance on existing irrigation systems in use in the vegetable and rice farming areas | Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> Higher crop and vegetation resilience Increased food security | NSAP | Action 8.1 |
| | 5. Cessation of sugarcane production on marginal sloping land and coastal lands. | Drought/ Extreme temperatures/ Sea level rise | Y | <ul style="list-style-type: none"> Decreased land degradation | INC | Action 6.2.3 |
| | 6. Identify and protect cropping land against encroachment from poorly controlled urbanization and the relocation of people forced from low-lying land. | Sea level rise | N | <ul style="list-style-type: none"> Increased food security | PFST | Step 4 |
| | 7. Promote and plant live-tree shelter belts to protect inland crops and soils from coastal winds and salt spray. | Cyclones | Y | <ul style="list-style-type: none"> Higher crop and vegetation resilience Increased food security | PFST | Step 14 |
| | 8. Conduct research on wetland and drought tolerant crops. | Drought | N | <ul style="list-style-type: none"> Increased community capacity | DRM | Activity 1.4.1 |
| | 9. Conduct research on sloping land agriculture. | Drought/ Heavy rain | N | <ul style="list-style-type: none"> Decreased land degradation | DRM | Activity 1.4.2 |
| | 10. Work with NGO's (e.g. MORDI) to collect and collate historic | Cyclones/ | N | <ul style="list-style-type: none"> Increased community | DRM | Activity 2.1.1 |

| Exposure Unit | Action | Addressing the following impacts | Community focused (Y/N) | Specific Adaptation Benefits / Higher Resilience due to... | Source Document | Action # |
|--|--|---|-------------------------|---|-----------------|------------------------------------|
| | information on disaster prone areas and develop proxy indicators. | Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | | <ul style="list-style-type: none"> capacity Decreased land degradation | | |
| Crop Production / Livestock Production | 11. Applying practical models and methodologies for soil classification, land evaluation, crop suitability and land use planning; | Drought/ Sea level rise | N | <ul style="list-style-type: none"> Decreased soil erosion Increased food security | RLUP | Objective 7.6 |
| | 12. Developing and applying practical on-farm approaches for the biological and/or mechanical control of soil erosion and amelioration of soil physical and chemical properties; | Drought/ Heavy rain | Y | <ul style="list-style-type: none"> Decreased soil erosion Increased food security | RLUP | Objective 7.4 |
| | 13. Promotion of sustainable agriculture to offset a number of the effects of climate change | Cyclones/ Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> Increased resilience of crops and livestock Increased food security | INC | Action 6.1.2 |
| | 14. Promote the use of traditional and non-traditional sustainable agroforestry systems of mixed species planting as buffer for protected and other sensitive areas. | Cyclones/ Drought/ Extreme temperatures/ Heavy Rain | Y | <ul style="list-style-type: none"> Increased resilience of crops and livestock Increased agrobiodiversity | PFST | Step 26 |
| | 15. Promote the diversity of different cyclone, drought and salt tolerant species and cultivars of key crops but also species and breeds of key livestock for food and cash income. | Cyclones/ Drought/ Extreme temperatures/ Sea level rise | Y | <ul style="list-style-type: none"> Climate resilient species and cultivars | PFST | Step 5 & 28 |
| | 16. Promote and improve agricultural extension (incl. CC&DR preparedness and response) to communities, via meetings, training workshops, TV and radio programs, education leaflets, etc. | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | Y | <ul style="list-style-type: none"> Increased community capacity | PFST NSAP RLUP | Step 29 Action 7.7 Objective 5b).1 |

| Exposure Unit | Action | Addressing the following impacts | Community focused (Y/N) | Specific Adaptation Benefits / Higher Resilience due to... | Source Document | Action # |
|--|---|---|-------------------------|--|-----------------|----------------|
| Crop Production / Livestock Production | 17. Promote Integrated Pest Management, pest surveys and biological pest control for control of key pests on crops and livestock | Drought/ Extreme temperatures/ Heavy Rain | Y | ▪ Higher crop and livestock resilience | PFST | Step 22-25 |
| | 18. Promote water capture and storage systems and improved irrigation technologies (e.g. drip irrigation, bucket irrigation, rainwater harvesting) to supplement the rainfall for key crops and livestock | Drought/ Extreme temperatures | Y | ▪ Secured water supply ▪ Increased food security | PFST | Step 3 & 11 |
| | 19. Promote hydroponic and aqua-ponic technologies to diversify the food production systems | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | Y | ▪ Increased food security | PFST | Step 5 |
| | 20. Develop quantitative and qualitative profiles of high risk communities | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | Y | ▪ Increased community preparedness | DRM | Activity 2.2.2 |
| | 21. Initiate an inter-agency consultation to harmonize community DRM plans with agency activities | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | ▪ Increased community preparedness | DRM | Activity 2.4.2 |
| | 22. Work with NGO's (eg MORDI) identify and prioritise infrastructure requirements (e.g. nurseries, seed stores, livestock feed stores), including design and costings | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | ▪ Increased food security | DRM | Activity 2.5.1 |

| Exposure Unit | Action | Addressing the following impacts | Community focused (Y/N) | Specific Adaptation Benefits / Higher Resilience due to... | Source Document | Action # |
|---------------|---|---|-------------------------|---|-----------------|---------------------------|
| | 23. Initiate an inter-agency consultation to resources for improving community infrastructure | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | ▪ Increased food security | DRM | Activity 2.5.2 - |
| | 24. Construct the required infrastructure (e.g. nurseries, seed stores, livestock feed stores) | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | Y | ▪ Increased food security | DRM | Activity 2.5.2 |
| | 25. Support farmers and communities in the mainstreaming of climate change adaptation and mitigation efforts into agricultural sector plans and all relevant national, sub-national and village policies and practices. | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | Y | ▪ Increased community capacity | PFST | Step 1 |
| | 26. Conduct climate change-focused agricultural research into flexible farming systems that are tolerant to climatic variability and based on Pacific farmers' needs and drawn upon their skills and expertise. | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | ▪ Increased community capacity | PFST INC | Step 6 Action 6.2.3 |
| | 27. Share "lessons-learned" of climate change adaptation initiatives on sector and community level with neighboring countries. | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | ▪ Increased community capacity ▪ Climate resilient species and cultivars | PFST NSAP | Step 7 Action 9.4 |
| | 28. Implement monitoring and evaluation systems (community M&E surveys) to determine the success of agricultural adaptation strategies so that farmers can learn from their | Cyclones/ Drought/ Extreme | Y | ▪ Increased community capacity | PFST DRM | Step 30 Activity 2.6.1 |

| Exposure Unit | Action | Addressing the following impacts | Community focused (Y/N) | Specific Adaptation Benefits / Higher Resilience due to... | Source Document | Action # |
|----------------------|---|---|-------------------------|--|-----------------|----------------|
| | mistakes and successes and share this vitally important information. | temperatures/ Sea level rise/ Heavy Rain | | | | |
| | 29. Secure additional finance resources to implement the appropriate adaptation options in agriculture sector | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | <ul style="list-style-type: none"> ▪ Secured financing ▪ Increased community capacity ▪ | NSAP | Action 9.4 |
| Livestock Production | 30. Ensuring domestic herbivores are managed to maintain and restore vegetation in an ecologically sustainable state. | Cyclones/ Drought/ Extreme temperatures | Y | <ul style="list-style-type: none"> ▪ Higher crop and vegetation resilience | RLUP | Objective 7.7 |
| | 31. Conduct research technology for producing alternative stock feeds | Cyclones/ Drought/ Extreme temperatures/ Sea level rise/ Heavy Rain | N | <ul style="list-style-type: none"> ▪ Increased community capacity | DRM | Activity 1.4.3 |

Developing a Typology for Early Adaptation Action (No- and low-regret options)

One of the initial findings of the literature review was that there was no clear definition of a low- or no-regret option (see box). The review therefore recommended it would be useful to develop a **typology** to help categorise Early Adaptation Action (i.e. No- and Low-Regret Options).

Definitions found in the literature review

There is a relatively clear and well defined definition of a '*no-regret*' adaptation option. This is included in the IPCC and widely used in the literature and defines 'no regret' options as *projects or policies that generate net social and/or economic benefits irrespective of whether or not climate change occurs*.

However, a few papers define 'no-regrets' adaptation as actions that generate net social benefits under all future scenarios of climate change and impacts, noting that this implies the benefits are in a future period.

In contrast, there is no clear definition of 'low- regret' options, and the use of the term varies widely.

- Some commentators highlight that no-regret options often have opportunity, policy or transaction costs, and thus should be more accurately referred to as low regret options (Wilby and Dessai, 2010).
- Others define low regret options as adaptation where the associated costs are relatively low and the benefits in addressing current climate variability are relatively high (e.g. Conway and Schipper, 2011).
- A variation on this definition is where the costs are relatively low and the benefits may be relatively large, while benefits arise under projected future climate change (UKCIP, 2006, HMT, 2009).
- Others (e.g. Ranger and Garbett-Shiels, 2012) define low regret measures as desirable over most, but not all, possible scenarios.

Another term commonly used in the literature is 'win-win', which is widely defined as options that address climate impacts but also have other environmental, social or economic benefits (UKCIP, 2006). Some of the development literature defines win-win options as having development benefits while also reducing exposure and sensitivity to climate variability (Conway and Schipper, 2011).

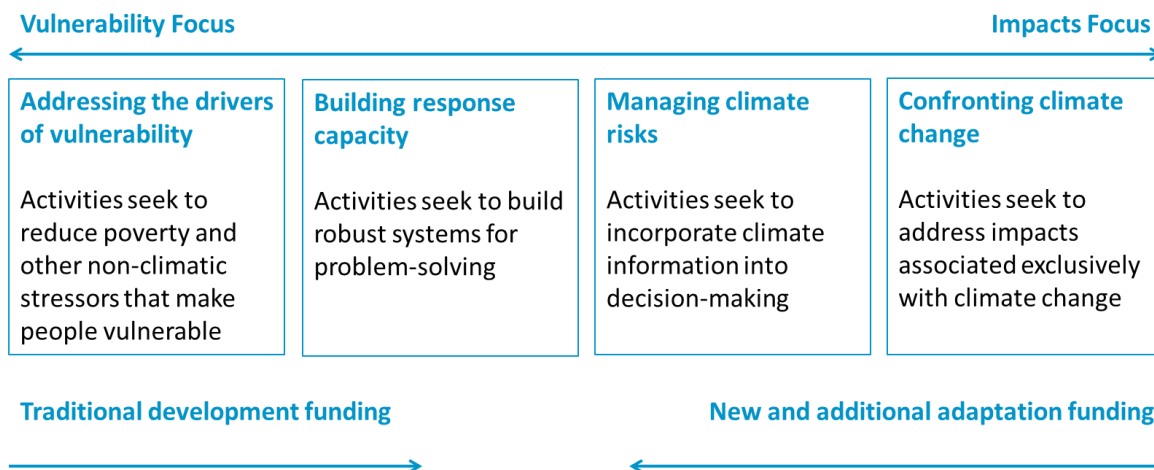
Finally, some of the literature defines low-regret options as those that are robust or flexible, i.e. consistent with (iterative) adaptive management, as these options avoid high-cost irreversible options. These options include the building of adaptive capacity and options (such as monitoring or research) which improve later decisions, as well as measures that keep future options open and/or minimise lock-in and minimise regret.

Following the literature review, we have developed a typology of early adaptation options that are potentially no- or low-regret, and have explored some of their characteristics, with the view of developing the guidance on how to assess them. To progress this, we have use a series of questions to help map out the typology and relevant questions. These are discussed in turn below.

1) What are the potential areas for adaptation (problem types)?

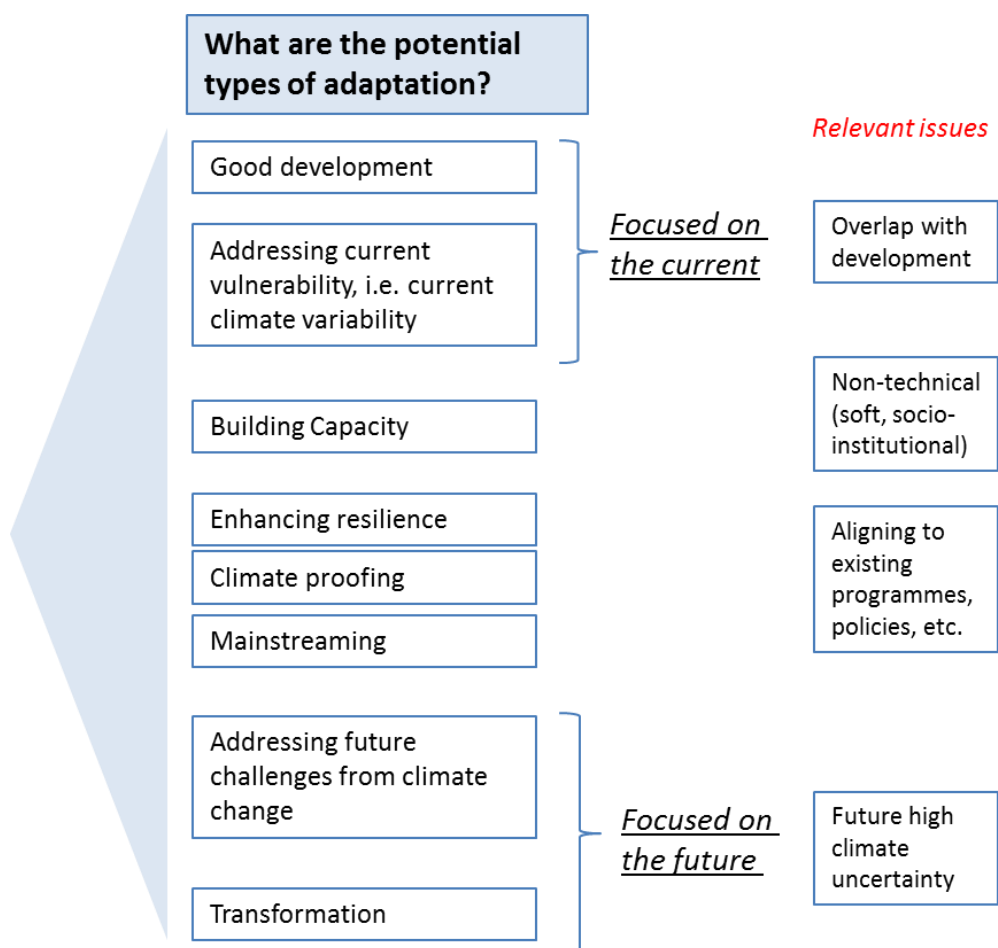
A useful place to start is to ask what form of adaptation might be advanced in the developing country context, and from this to look at possible low-or no-regret actions. This includes all adaptation, not just planned government action. At a very aggregated scale, there is a broad consensus that adaptation in developing countries involves addressing current vulnerability (current climate variability) and future climate change.

However, there is now a broad consensus that in translating this framework to practice, there is a more complex and dynamic set of adaptation interventions, which start with good development and addressing existing vulnerability, through intermediate steps that involve building capacity, through to addressing future climate change. One of the more commonly used frameworks for presenting this is shown below.



Source Klein and Persson (2008), adapted from McGray et al. (2007).

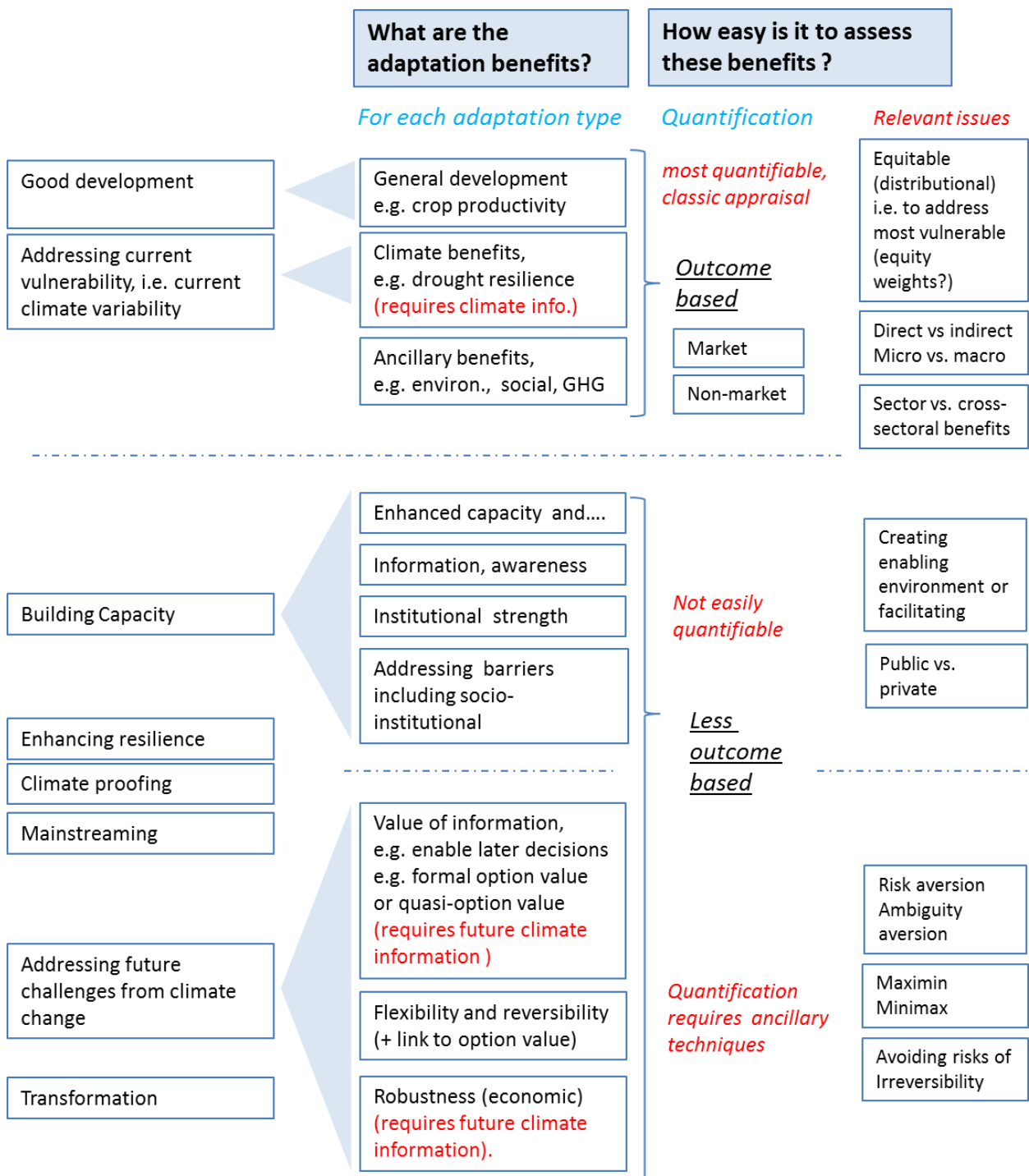
On the basis of the previous literature review, we have identified a more disaggregated list of types of adaptation. Some of these (at the top) are focused on the current (and climate variability). Some (at the bottom) are more focused on future climate change.



While many low- and no-regret options will fall in the top part of the list, there will be low- and no-regret options across all of the possible adaptation areas. As set out in the IFC guidance (and the existing reference to low- or no-regret options), a programme of early adaptation may want to include elements across several of these areas, noting this matches the emerging recommendation from the IPCC to develop portfolios of options, as part of an iterative risk framework.

2) What types of adaptation benefits exist and how easy are these to assess?

The next step is to identify the potential low-and no-regret options for each of the adaptation types above, based on the types of benefits these various interventions achieve. The adaptation benefits and a quick analysis of how easy these benefits are to assess is presented below.



This highlights key issues with the types of adaptation benefits and their analysis, as follows:

- General development benefits, i.e. good development, which includes classic no--regret options such as better pest and disease management leading to enhanced crop productivity, which provide immediate benefits (measured by a present value analysis) provide a more robust sector to cope with future climate change. These tend to have a very broad applicability and high transferability. These are essentially just development, and have low resonance with climate.

- Options that tackle current climate variability (existing vulnerability) also involve no- and low-regret options that are good development, but they have a more explicit climate element and thus are more relevant in the context of adaptation. As an example, soil and water conservation is a basic development option, which enhances productivity, but it does this primarily by reducing soil erosion or enhancing moisture retention, thus addressing existing climate risks. As this option reduces climate related vulnerabilities, it provides relevant resilience to a changing climate. Note however that to assess current benefits require analysis of current climate information. Moreover, the benefits of these options – and their no or low-regret characteristics - are strongly linked to local and specific risks, i.e. current vulnerability and climate variability. The benefits and low/no regret characteristics will vary and thus there are extra issues in assessing the transferability of the options to all countries and regions.
- Win-win options are generally defined as having climate benefits but also additional ancillary benefits. These are often environmental or social benefits, and in the adaptation context, could include options that are synergistic with mitigation (e.g. in reducing GHG emissions). As a consequence, it may be that these benefits are less amenable to quantification, or may rely on non-market valuation to express these in monetary terms.

In many cases, options that are forms of good development or that tackle current climate variability will often be outcome based, e.g. they involve physical options or measures. There are, however, important differences in how the benefits are assessed, that affect how we might measure the low/no regret potential.

For options that are good development, a traditional appraisal framework can be applied, noting that the well understood constraints in capturing non-market or informal economy benefits. For many of these options, there is general transferability for low- or no-regret options, and the study can draw on existing development economics literature.

The benefits in addressing options focused on current climate variability involve more challenges, as they require analysis of baseline climate risks, and there are additional issue of transferability, because baseline risks will be site specific. Thus while a conventional appraisal framework can be used, there is a more complex analysis because of the consideration of climate.

A number of relevant issues are identified even for these early options, which relate to the identification and analysis of low/no regret options/characteristics.

First, it is generally easier to identify and quantify benefits in an individual sector and impact category. It is much more difficult (and time and resource intensive) to capture cross-sectoral benefits. However, failure to do some may result in options that have negative effects on other sectors, or do not represent the fully socially optimal option.

Second, there are different categories of benefits, which include indirect as well as direct benefits. As an example, putting in adaptation measures to reduce flood risk has an obvious direct benefit in reducing direct damage (or losses) from physical damage to buildings, or loss to crops. In addition, there will also be direct benefits in reducing non-market impacts, such as deaths or injuries (sometimes called intangibles in the DRM literature). However, it also reduces indirect effects that arise from floods, e.g. the loss of industrial production or the disruption to transport (which may have effects outside the immediate area affected), as well as indirect non-market effects such as post-flood health impacts from increased vulnerability of survivors. These indirect effects also include the wider economy or macro-economic effects, e.g. the cascade of impacts through the economy (as captured by CGE or I-O), the diversion of scarce economic resources away from other, productive activities, etc.

Third, there are also some additional issues in relation to the distributional benefits of action. A strong focus in the negotiations is to focus on the most vulnerable, noting these groups are often difficult to capture in formal appraisal. The potential application of equity weights is sometimes advanced, but there is rarely application in practice.

Finally, while assessing these options is relatively easy in theory, practical analysis and applicability requires consideration of existing baseline conditions. As an example, even if soil and water conservation is a potentially good low-regret measure, there maybe existing development programmes in place, and there is a need to look at the marginal adaptation intervention on top of this baseline. This issue is not new, but it requires a greater level of analysis in considering the transferability of options and the application.

Looking at the figure, there is a second set of benefits centred around capacity, socio-institutional issues, barriers, etc. This reflects a growing recognition of the role of socio-institutional issues in climate adaptation (Berkhout et al., 2006; Moser and Ekstrom, 2010) and the need to consider adaptation as a process, recognising barriers to adaptation and underlying governance issues. These barriers are one of the key reasons why no-regret options are not already implemented. Therefore removing barriers, or enhancing capacity to enable adaptation, are forms of low/no regret options:

- Capacity building benefits. Capacity building involves (UKCIP, 2008): gathering and sharing information, i.e. undertaking research, collecting and monitoring data, and raising awareness through education and training initiatives; creating a supportive institutional framework that might involve changing standards, legislation, and best practice guidance, and developing appropriate policies, plans and strategies; and creating supportive social structures, such as changing internal organisational systems, developing personnel, or other, resources to deliver the adaptation actions, and working in partnership.

There are a wide ranging set of options that fall into this category. Many of these are low cost, and will be forms of low-regret options. However, many of these benefits are much more challenging to quantify in appraisal, as they are often soft or non-technical in nature.

It is stressed that in many cases, advances in capacity are needed to fully take advantage of the implementation of good development or vulnerability focused options highlighted above. This again highlights the need for portfolios of low-regret options, i.e. a successful intervention (as measured in value for money terms) is more likely if a combination of capacity building and hard options are implemented together.

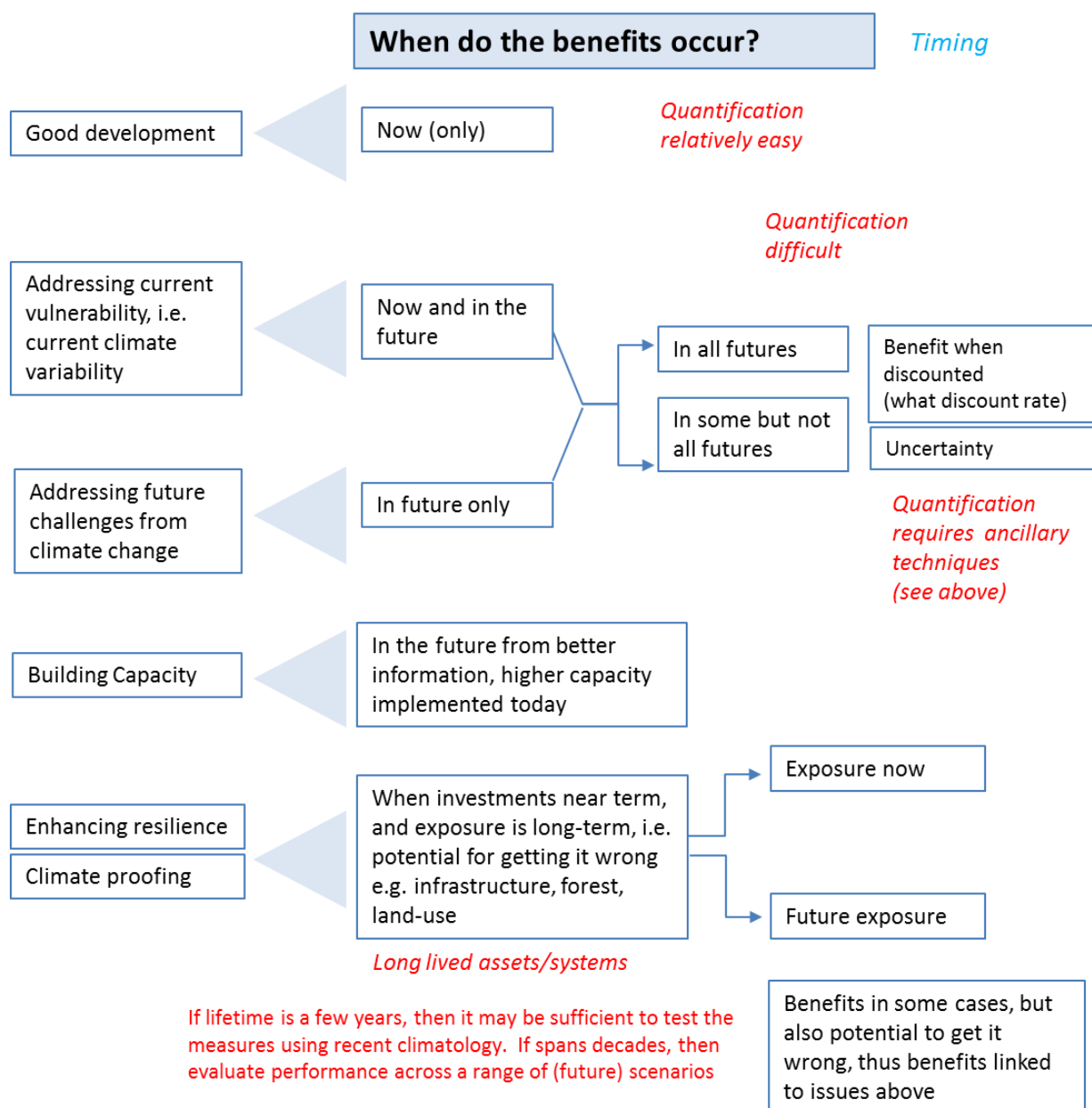
Finally, there is a further set of options that more orientated towards future options and provide their benefits, and their low/no regret characteristics, by addressing uncertainty. These involve:

- Early options which start to build the foundation or provide the information for addressing longer-term challenges. This could be information or research (similar to building capacity discussed above) that will facilitate more effective responses in the future, i.e. by allowing better decision making. Many of these are again likely to be low cost and can therefore be considered low regret. These need to be implemented early on in the adaptation process to allow these later benefits to be realised, e.g. if there is a potential long-term threat to coffee production, then an early monitoring system and research programme is critical, but this needs to be in place early enough to provide sufficient time-series data to allow good evidence-based decisions later. This links to the issue of option value / value of information.
- There are a set of options with benefits that help address the problem of uncertainty. These relate to concepts such as flexibility or robustness. Options that demonstrate flexibility or robustness, and help address uncertainty (and reduce the risks of lock-in and irreversibility), are therefore low regret when compared to options that don't have these characteristics.

For these options, the analysis of benefits becomes much more complicated, because it requires analysis of the benefit of reducing uncertainty, or analysis of the benefit of flexibility or robustness over an option without these characteristics. In formal economic analysis, this involves the application of complex techniques (e.g. robust decision making, real options analysis), though it is also possible to apply the concepts of these approaches in a light-touch approach (as per the DFID How to guidance on uncertainty).

3) When do the benefits occur?

Looking at the low/no regret options above, it is clear that there are different time periods involved for different types of options and their benefits. The classic definition of a no-regret option is one that gives benefits today. This is relatively easy to assess in terms of appraisal. However, as one moves to the inclusion of low-regret options, this includes options that might have benefits today, or in the future, or both. For future benefits, this involves uncertainty, i.e. benefits may arise under some but not all futures, as well as the issue of discount rates.



A complex mix of timing is involved across different types of adaptation and interventions. Thus, as well as the issues of future benefits and the issues of uncertainty, there are also potential low/no regret options that span time-periods.

First, in the context of long-term challenges, and the need for early action such as from monitoring and research (low regret) to enable better long-term decisions, then these reflect short-term options that deliver medium term benefits. Upfront costs are low. The benefit is the value of information delivered, noting the challenge of quantifying this.

Second, where there are investments in the short-term that have a long life-time, notably infrastructure (but also for other areas, such as forestry, land-use planning), then low regret options may be ones that provide flexibility or robustness, i.e. avoiding lock-in, but there may be uncertainty in these future benefits. These benefits generally require more detailed appraisal approaches to assess, e.g. robust decision making, etc.

4) What types of adaptation costs are there? How easy are these to assess? What do the costs occur?

We have also undertaken a similar exercise for adaptation costs.

Many low regret options are defined by having low costs (though this is not always the case). However, it is important to capture the full types of costs, because a classical low cost option may involve other cost categories, noting these may be easier or more difficult to quantify.

These additional cost elements are important because the inclusion of some of these may flip a no-regret measure to a low regret measure (e.g. when opportunity costs are included), or make a promising low-regret option uneconomic.

As examples, many of the sustainable agricultural options, which are widely cited as being low or no-regret, actually have high opportunity costs. For example, McCarthy et al (2011), identify the opportunity costs of land-use for fallows or soil conservation.

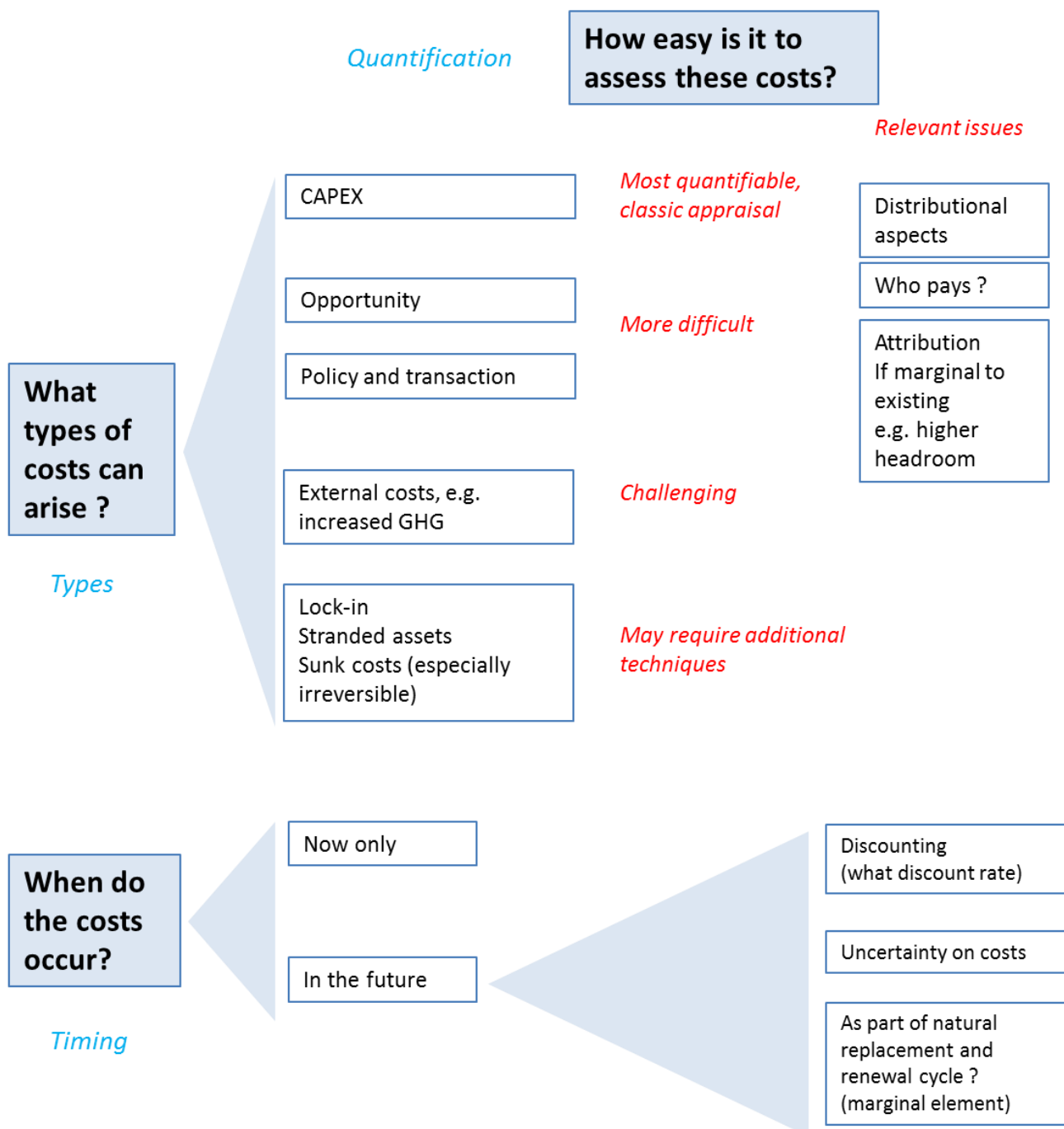
Furthermore, similar to the lessons from the mitigation domain, many options involve various policy or transaction costs, which are omitted when considering unit costs alone. In some cases, these costs represent major barriers to implementation and thus the successful implementation of options will only occur if these issues are tackled.

These issues caution against an overly narrow analysis of technical unit costs to select low/no regret options. However, some of these cost categories are much harder to quantify, thus they are often omitted or presented in qualitative terms.

There may also be various external costs involved, e.g. some options (e.g. fertiliser use, diesel powered water pumping for irrigation, building cooling, etc.) may increase GHG emissions, and these also need to be factored into the cost analysis, noting that these are often harder to quantify.

In the context of uncertainty, there is also a need to consider the economics of failing to address uncertainty, including issues of sunk costs and stranded assets, etc., aligned to the uncertainty analysis of benefits presented above.

There is also an issue on the timing of the costs, though generally this is simpler than for benefits above because uncertainty is lower, and cost profiles are generally concentrated earlier. Nonetheless, some costs arise in the future, e.g. from ongoing maintenance costs, and thus issue of discounting may also arise. It is also stressed that there is always uncertainty on costs, though this is often omitted in appraisal analysis, due to the variation and transferability involved, but also because of differences between ex ante appraisal and ex post out-turns.



5) Overall framework

The information above shows that there are different types of low- and no-regret options, which are addressing different types of problems.

These each have different elements in relation to timing, nature of benefits, quantification, etc.

For the guidance to develop a useful toolkit, it is therefore necessary to differentiate each type of option, and develop sets of questions to allow the analysis of what issues are important in delivering low/no regret and thus value for money.

An initial summary is presented below. This is a work in progress, but highlights the types of issues and implied questions that will be used in the toolkit.

| Categories of adaptation | | | | |
|---|--|--|---|--|
| Good development | Addressing current vulnerability | Building Capacity | Enhancing resilience / climate proofing | Addressing future challenges of CC |
| Types of low or no regret options/characteristics | | | | |
| Productivity Efficiency Better maintenance Etc | Reducing current climate risks Climate relevant component | Information Monitoring Research Awareness raising | Screening Mainstreaming Marginal changes | Information Robustness (R) Flexibility (F) |
| Timing of benefits | | | | |
| Now | Now (and potentially in the future) | Now For the future | As part of current investment (marginal) or replacement/renewal | Elements now to improve decision s in the future + future for R/F |
| Nature and analysis of benefits | | | | |
| Quantitative Outcome focused | Quantitative Outcome Climate risk specific | Process Soft | Quantitative Some uncertainty | Quantitative or qualitative Climate risk and uncertainty specific |
| Issues | | | | |
| Non-market Cross-sectoral Indirect Distributional (1) | As (1) + Main benefits area climate risk specific | As (1) + Main benefits harder to quantify | As (1) + Involves futures and uncertainty | As (1) + Information, resources, complexity uncertainty |

As an example, for options focused on current climate variability, a set of promising options can be identified (e.g. early warning system) and a discussion of the key issues in the application and transferability of these options presented. A set of questions can derive from the possible issues involved in delivering aspects of value for money, e.g. in relation to the climate risks and transferability, or the potential cost categories involved, oetc.

As discussed at the workshop, this will take the form of a high level and a more project level framework, i.e. for

- A country level decision making toolkit, e.g. which is probably targeting early scoping and identification of early VfM actions;
- A more detailed toolkit, which is more focused on prioritisation.

The general typology will be relevant for both levels, though there will be differences between the decision trees on the relevant issues.

The next stage is to take the examples from the detailed sector reviews (agriculture and DRM) and start working through some practical examples.

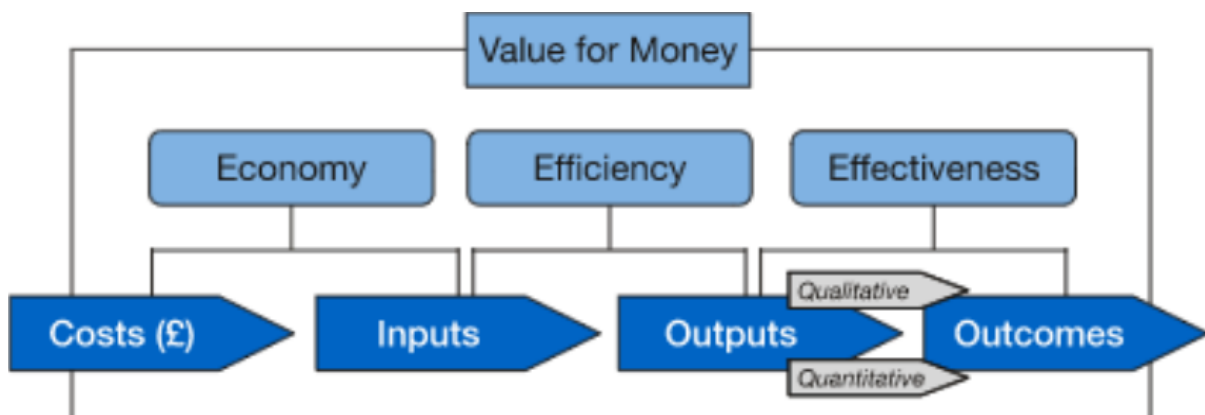
Aligning with DFID Value for Money?

A final part of this typology review has been to consider the way the typology aligns with the existing DFID guidance on Value for Money (VfM).

At a project level, DFID guidance supports VFM analysis at three levels

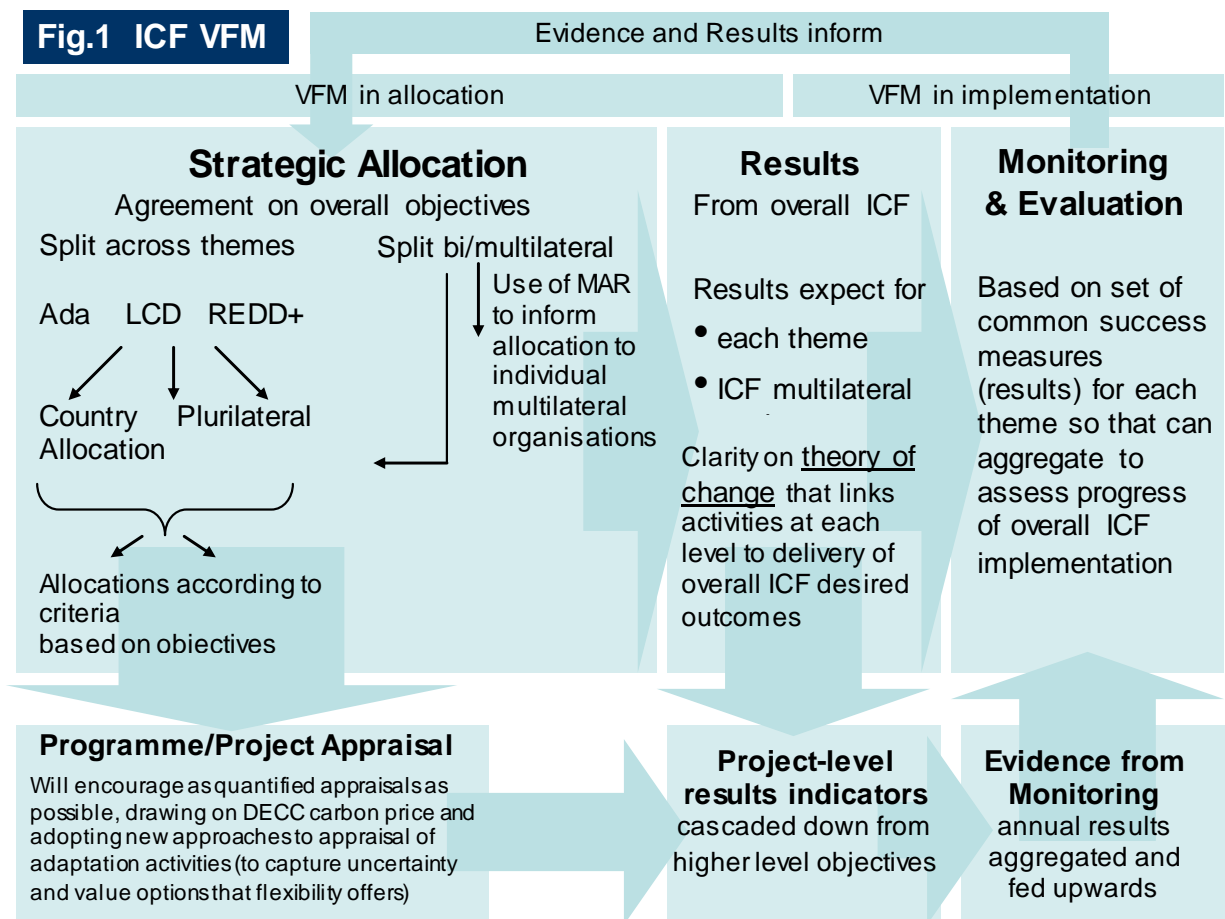
- *Economy (spending less)*: This refers to ensuring lowest cost procurement of goods and services within project design, and focuses on making sure that the unit costs are benchmarked against market norms. For example, from an adaptation perspective, this might involve ensuring that the costs of a water saving technology purchased were in line with international market expectations.
- *Efficiency (spending well)*: This refers to ensuring that the choice of goods and services to be procured ensures that the procurement of goods and services results in the envisaged outputs. The input to output ratios are the key consideration. From an adaptation perspective, this might involve ensuring that the technology selected would deliver the desired reduction in volumes used for irrigation compared to similar alternative technologies:
- *Effectiveness (spending wisely)*: This refers to the selection of those outputs most likely to result in the desired outcomes (and impacts). From an adaptation, perspective, this could be ensuring that the water saving technology selected was the most (cost) effective way of making an agricultural community more resilient. Alternatives to be considered might include, adopting more drought resistant crops, investing in water capture and storage capacity, or diversifying livelihoods away from agriculture.

DFID ICF Value for Money



In this context, the framework is relevant in making sure a low or no-regret option achieves value for money through the implementation and procurement process, though there is a more relevant alignment with effectiveness.

IFC also uses VFM considerations at a strategic level in relation to the allocation of resources and at a project level to improve design and maximise outcomes. This is set out below.



- At a *strategic* level, VFM may be used to support allocation approaches. For example, VFM may inform the balance between capacity building and project investment, or the allocation of resources between countries or sectors on the basis of vulnerability. VFM may be viewed from an operational issues, such as the potential speed of disbursement, absorption capacity of different beneficiaries and delivery channels, and scaling up/leverage potential;
- At an *implementation* level, VFM can drive effective project design through the promotion of **low and no regret measures**, the identification of co-benefits (mitigation or poverty reduction), and innovation potential. Results frameworks are used to provide a common set of indicators that can be aggregated

The promotion of no- and low-regret measures (considered to be where benefits exceed costs irrespective of the climate scenario) can be considered a supporting factor to ensure effectiveness both at the project and ICF level.

No and low regrets approaches are promoted in ICF guidance as a way of ensuring a fair balance between across competing development priorities. Several no-regret options are identified in the ICF Implementation Plan.¹

- Continued investment in knowledge and climate data – both globally and at country level;
- Integrating adaptation into national plans and budgets to strengthen climate monitoring;
- Strengthening global, regional and national disaster risk reduction strategies’;
- Improved water shed management;
- Supporting sustainable agriculture approaches and improved pasture management.

¹ International Climate Fund (ICF) Implementation Plan 2011/12 – 2014/15 Technical Paper

These categories of low and no-regret options can be assigned across the typology above. The typology allows a way of categorising potential options and highlighting the issues in ensuring they are low/no regret, and will deliver VfM.

As examples:

- Investment in knowledge and climate data is closely aligned with capacity building, and providing the information base for improving long-term decisions. The typology above highlights it is more difficult to assess the explicit benefits of these types of soft options, thus questions will be needed to help DFID officers assess the potential benefits.
- Integrating adaptation into national plans and budgets to strengthen climate monitoring involves a national level perspective, and crosses over a number of areas, which can be identified through the typology, e.g. the areas that are good development, that are relevant to current climate risks, to enhancing future resilience.
- Strengthening disaster risk reduction strategies is a classic response for addressing current climate variability. The issue involved in climate specific risks is highlighted, as well as the focus on a mix of options. (i.e. a mixture of soft and hard measures).
- Improved water shed management is effectively good development. There are already numerous programmes of integrated water resource management, and information from these can provide information on these types of programmes.
- Supporting sustainable agriculture approaches and improved pasture management is largely associated with good development and addressing current climate variability. The examples earlier raise the issues of non-market benefits, and issues such as policy and opportunity costs, thus the guidance will include reference to such elements.



Minimum Standards for Embedding Disaster Resilience in DFID Country Offices

This note is part of a series of guidance notes on disaster resilience prepared by CHASE¹ for DFID Country Offices and partners.

Introduction

The DFID Business Plan for 2012-2015 commits DFID to embed disaster resilience in at least eight DFID Country Offices by March 2013 and all DFID Country Offices by 2015². This document sets out the minimum standards a country office should reach to meet the Business Plan commitment.

Work on disaster resilience or disaster risk reduction is not new. But the aim of building disaster resilience across the portfolio will be new for many DFID country offices. Embedding disaster resilience means ensuring investment decisions are informed by disaster risks and that programmes are designed or adapted to be resilient to one-off, regular or on-going disasters.

Disasters vary in nature and size – from natural disasters such as droughts or floods to man-made conflict-driven disasters. Building disaster resilience is an important way of protecting poverty gains and saving lives in the face of shocks and stresses. It is also good value for money. A UK-funded study found that in Kenya - over a 20 year period - every \$1 spent on disaster resilience would result in \$2.9 gained in the form of reduced humanitarian spend, avoided losses and development benefits.

Minimum standards of disaster resilience

The steps outlined here are designed to help Country Offices think through what it means to become disaster resilient, drawing on best practice. Most steps can be done quite quickly, drawing on existing assessments, strategies and business cases. The steps are designed to be integrated with Country Office Operational Plans.

The seven steps are:

1. Designate an Office Champion for disaster resilience.
2. Carry out a multi-hazard risk assessment.
3. Develop a country/regional disaster resilience strategy.
4. Disaster-proof new business cases.
5. Develop new programmes and adapt existing programmes to support disaster resilience.
6. Develop an emergency humanitarian response plan.
7. Contribute to bi-annual reporting to ministers on disaster resilience.

¹ DFID's Conflict, Humanitarian and Security Department

² This includes DFID's regional engagement in the Caribbean and Sahel.

CHASE can provide on-the-ground advisory support and catalytic funding, particularly for the analytical and programme work outlined in steps 2 - 6.

Step 1: Office champion for disaster resilience

The Head of the DFID Country Office should designate a lead and establish a cross-disciplinary team to drive forward development of the disaster resilience strategy and monitor impact and results.

Step 2: A Multi-hazard risk assessment

Disaster resilience begins with a firm understanding of the:

- **Shocks and stresses.** The degree and nature of disaster risks that a country or region faces, now and in the future. This would include risks of natural and man-made disasters;
- **Vulnerability** of populations, institutions, infrastructure and economies, taking account of internal variation, impacts on women and girls and conflict risks;
- **Leadership, capacities and investment** of the host government and other key actors – both humanitarian and development – to cope with disasters;
- **Probable economic, political and social impacts of disasters** and their implications for DFID's investments and for long-term growth and development.

A multi-hazard risk assessment should look at the issues above, drawing on existing analysis commissioned for each office's Operational Plan, internal reviews of integrating climate change (Strategic Programme Reviews) and existing humanitarian and development programmes. Information will also be available from the partner government, UN, World Bank, private sector, NGOs and other donors.

Step 3: A country/regional disaster resilience strategy

A disaster resilience strategy sets out the steps to embed disaster resilience within the office, drawing on the multi-hazard risk assessment. Ideally, the strategy would be developed jointly with other parts of the UK Government. Conflict sensitivity of interventions should be looked at in fragile and conflict states. The strategy should cover:

- **The range of opportunities and obstacles to disaster resilience.** Opportunities (or obstacles) for the UK and others to embed disaster resilience within i) existing programmes; ii) new programmes; iii) investing in targeted disaster resilience programmes, and the costs and benefits of these;
- **What will be done, by when, with what results.** The process to embed disaster resilience, including "quick wins", longer term work and expected results;
- **Resources required.** Staffing, finance and advisory support required to implement the strategy.

The strategy could also cover opportunities for lobbying the government or partners to enhance their engagement/leadership on disaster resilience. Once developed, the strategy can be tied into the operational planning process each year.

Step 4: Disaster-proof new business cases

The disaster risk assessment will influence new business cases, all of which should be considered for “disaster-proofing.” Business case risk assessments should assess disaster risk and how the impacts of a disaster will be managed through the design of the programme. The consideration of disaster risk in the design of new business cases can start straight away; it need not be held up while the strategy is developed.

Step 5: Develop new programmes and adapt existing programmes to support disaster resilience

Offices will take forward the strategy in different ways depending on the context and their starting point. In the first year, most Country Offices will start to adapt programmes to be more disaster resilient. Offices are also encouraged to develop new disaster resilience programmes.

The table at the end of this note gives examples of UK programmes that have either been adapted for disaster resilience or developed to target disaster resilience.

Sectoral guidance notes will be included in the broader Disaster Resilience how-to-note to be released in autumn 2012. These will include additional and more detailed case studies.

Step 6: Developing emergency response plans

DFID Country Offices that are particularly prone to disasters should have emergency response plans in place to facilitate a rapid humanitarian response. This should assess the state of preparedness and contingency planning of the host government, UN, World Bank, Red Cross/Crescent societies, local and international businesses, NGOs and other donors.

Step 7: Bi-annual Reporting

CHASE will update ministers and No 10 on the disaster resilience commitment twice per year. CHASE will co-ordinate brief updates from Country Offices on their disaster resilience work to feed into this reporting.

CHASE

July 2012

Examples of DFID Programmes Developed or Adapted for Disaster Resilience

| | Sector | Programme example |
|--------------------------------|---|--|
| Adapted programmes | Disaster-proofing investments in education programmes | Integrating disaster resilience in the education sector in Bangladesh. Cyclone Sidr fully or partly destroyed just under 6,000 schools. In the aftermath, rebuilding was undertaken in such a way that schools could double as cyclone shelters. Climate change and disaster risk reduction were also integrated into the school curricula. |
| | Making social protection mechanisms more flexible so they can scale up in response to shocks or stresses | Productive Safety Net Programme in Ethiopia. This programme supports 7.8 million people and has helped break the need for emergency food programmes by providing people with regular and predictable cash and food transfers. A new risk financing mechanism allows the programme to expand in times of shock, by increasing the period of time in which a person receives support or by adding new people. By helping to protect people from having to sell their assets, it allows people to recover much more rapidly when shocks occur. |
| | Strengthening links between development and humanitarian programming | Building resilient livelihoods in northern Kenya. In order to be more effective in building resilience in this arid area, DFID is placing much more emphasis on building much closer links between the delivery of social services, disaster risk reduction, social protection and emergency response, and creating the conditions for economic growth. This more integrated package of support consists of a Hunger Safety Net, Arid lands Support, Addressing Acute Malnutrition, Education and Market Access for the Poor Programmes. |
| | Building host government capacity for emergency preparedness | Support to Earthquake Readiness in Nepal is a new DFID programme, which is helping to improve national and international preparedness for an emergency response in the event of a major earthquake. The programme also helps to protect vital health services (including infrastructure) in the event of shocks and to strengthen community resilience. |
| Disaster resilience programmes | Use of insurance and contingency credit , immediately after a disaster to speed recovery | Caribbean Catastrophic Risk Insurance Facility (CCRIF) is the world's first regional facility that uses parametric insurance to give sixteen governments quick, short-term liquidity to mount response and early recovery in the event of major earthquakes or hurricanes. It is capitalised by participating countries and donor partners (DFID contributed £7.5 million), and taps into the international reinsurance market. Since 2007, the CCRIF has made eight payments totalling \$32 million. |
| | Piloting community-based disaster resilience programmes | Enhancing Community Resilience in Malawi is a joint donor programme with Ireland and Norway, supporting 1.2 million people to cope and recover better from extreme weather. It includes community-based adaptation programmes (e.g. savings and loan schemes, crop diversification and irrigation), improved information on disaster risk reduction and climate change, more effective early warning systems and strengthened capacity of national local government in disaster risk reduction and climate change adaptation. |



TOPIC GUIDE:

Adaptation: Decision
Making under Uncertainty

Nicola Ranger
June 2013



**EVIDENCE
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About Topic Guides

Welcome to the Evidence on Demand series of Topic Guides. The guides are being produced for Climate, Environment, Infrastructure and Livelihoods Advisers in the UK Department for International Development (DFID). There will be up to 30 Topic Guides produced in 2013-2014.

The purpose of the Topic Guides is to provide resources to support professional development. Each Topic Guide is written by an expert in the field. Topic guides:

- Provide an overview of a topic
- Present the issues and arguments relating to a topic
- Are illustrated with examples and case studies
- Stimulate thinking and questioning
- Provide links to current best 'reads' in an annotated reading list
- Provide signposts to detailed evidence and further information
- Provide a glossary of terms for a topic.

Topic Guides are intended to get you started on a subject you are not familiar with. If you already know about a topic then you may still find it useful to take a look. The authors and editors of the guides have put together the best of current thinking and the main issues of debate.

Topic Guides are, above all, designed to be useful to development professionals. You may want to get up to speed on a particular topic in preparation for taking up a new position, or you may want to learn about a topic that has cropped up in your work. Whether you are a DFID Climate, Environment, Infrastructure or Livelihoods Adviser, an adviser in another professional group, a member of a development agency or non-government organisation, a student or a researcher we hope that you will find Topic Guides useful.



Tips for using Topic Guides

I am going to be under the spotlight. How can a Topic Guide help?

The Topic Guides, and key texts referred to in the guides, cover the latest thinking on subject areas. If you think that a specific issue might be raised when you are under the spotlight, you can scan a Topic Guide dealing with that issue to get up to speed.

I have just joined as an adviser. Where should I start?

Topic Guides are peer reviewed and formally approved by DFID. They are a good starting point for getting an overview of topics that concern DFID. You can opt to be alerted to new Topic Guides posted on the Evidence on Demand website through Facebook, Twitter or LinkedIn. New publications of interest to advisers will also be announced in Evidence on Demand quarterly ebulletins.

I don't have much time. How long should I set aside for reading a Topic Guide?

The main text of a Topic Guide takes around three hours to read. To get a good understanding of the topic allow up to three hours to get to grips with the main points. Allow additional time to follow links and read some of the resources.

I need to keep up my professional development. How can Topic Guides help with this?

Topic Guides, while providing an overview and making key resources easy to access, are also meant to be stretching and stimulating. The annotated reading lists point to material that you can draw on to get a more in-depth understanding of issues. The Topic Guides can also be useful as aide-mémoires because they highlight the key issues in a subject area. The guides also include a glossary of key words and phrases.

I would like to read items in the reading list. Where can I access them?

Most resources mentioned in the Topic Guides are readily available in the public domain. Where subscriptions to journals or permissions to access to specialist libraries are required these are highlighted.

I have a comment on a guide. How can I provide feedback?

Evidence on Demand is keen to hear your thoughts on and impressions of the Topic Guides. Your feedback is very welcome and will be used to improve new and future editions of Topic Guides. There are a number of ways you can provide feedback:

- Use the Have Your Say section on the Evidence on Demand website (www.evidenceondemand.info). Here you can email our team with your thoughts on a guide. You can also submit documents that you think may enhance a Topic Guide. If you find Topic Guides useful for your professional development, please share your experiences here.
- Send an email to the Evidence on Demand Editor at enquiries@evidenceondemand.org with your recommendations for other Topic Guides.



About this Topic Guide

The purpose of this Topic Guide: *Adaptation Decision Making under Uncertainty* is to stimulate thinking about two major issues: first, how climate change may alter the long-term outcomes of development interventions today and second, how such interventions can be better designed from the outset to have outcomes that enhance climate resilience and are themselves robust and adaptable to long-term stresses, like climate change.

The Topic Guide is written for DFID staff, but is relevant to all development professionals. It is suitable for both non-experts and experts on climate change. It is not a comprehensive manual, but aims to provide sufficient information to enable development professionals to take some practical steps in their day-to-day work, as well as know where to look for more information.

The Topic Guide offers an overview of the latest thinking on how to manage the changing and uncertain climate in development decisions today. The key premise is that climate change will affect the long-term outcomes of many development interventions. Indeed, interventions that are beneficial today may prove to be damaging in the long term if they do not take account of climate change. This gives a strong rationale for ensuring that programmes and projects are robust and adaptable to climate change. Importantly, climate change and its uncertainties should not be an after-thought in development interventions – they must be addressed from the outset of the process and throughout the project cycle.

The specific challenge addressed in this Topic Guide is that the future climate is deeply uncertain. This is not just a scientific issue – it has real implications for DFID. If uncertainty is not tackled properly from the outset today, there is a significant risk of taking not enough, too many or the wrong types of interventions. This could mean a lower value for money of investments, or in extreme cases, wasted investments or adverse outcomes.

The central message from this Topic Guide is that accounting for the changing and uncertain climate need not be complicated and should not paralyse action. This Topic Guide introduces a range of concepts and tools for dealing with the changing and uncertain climate in designing and implementing development interventions – many are suitable for all development professionals, but in the final chapter we also include a set of more involved methods for those interested in quantitative options appraisal.

The Topic Guide begins with a brief introduction to the main issues concerning climate change adaptation and climate-resilient development from a DFID perspective. Section [II](#) then introduces climate uncertainty and explains where this is important in development interventions, giving a number of **case studies**. Sections [III](#) and [IV](#) then consider what practical steps development professionals can take to address the changing and uncertain nature of climate in their work. The first part discusses the design and implementation of policies and programmes that are robust to uncertainty. The second part focuses on more technical issues for quantitative options appraisal. Below is a document map to help direct readers to appropriate points in the Topic Guide.



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|---|--|
| General adaptation: | |
| The relationships between adaptation and development – their synergies and trade-offs | Sections I.1 , I.3 |
| The role of the public sector in adaptation | Box III.2 |
| The timing of adaptation – act now or later | Box III.3 |
| Implications for designing and implementing development interventions: | |
| Identifying where climate change needs to be accounted for | Section I.2 , II.2 and Fig. II.5 |
| What is the difference between climate change and the risks that we usually account for in options appraisal? | Box II.2 |
| How to design interventions that are robust to uncertainty | Section III |
| The project cycle | Section III.2 |
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| Prioritising interventions | Section III.3 |
| Practical issues in dealing with uncertainty | Section III.4 |
| Climate and impact information: | |
| Why are climate models so uncertain? | Box II.1 |
| Using climate information within options appraisal | Section III.2 , IV.3 |
| Tools: | |
| Risk and vulnerability screening | Box II.3 and Section III.2 |
| Types of adaptation measures (low-regrets, flexible, progressive) | Section III.1 |
| Science vs. policy-first decision making | Box III.1 and Section III.2 |
| Issues with conventional economic tools | Section IV.1 |
| Discounting | Box IV.1 |
| Methods for decision making under uncertainty (including robust decision making and real options analysis) | Section IV.2 |

About the author

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Executive summary

Climate change will affect the long-term outcomes of many development interventions.

This Topic Guide aims to help development professionals consider how interventions can be designed today to promote climate-resilient development and to have outcomes that are robust to the uncertainties over future climate risks. The concepts and tools introduced are relevant to managing all long-term risks and uncertainties in development interventions.

Adaptation is the only way to safeguard gains in development and poverty alleviation from the damages of unavoidable climate change. The poorest and most stressed people tend to be worst affected by climate impacts and have the least capacity to respond to climate change. Without effective adaptation and climate-resilient development, the poor could be driven deeper into poverty and the development gains achieved by organisations like DFID will be short-lived. The sustainability of progress against the Millennium Development Goals is under threat.

Climate change is not just an additional risk that can be managed separately, but affects many, if not all, of DFID's strategic priorities. Climate change and climate-resilient development are recognised as crucial issues for development organisations and will have implications at all levels of planning and implementation, from operational plans to individual projects. It is relevant not only for programmes where adaptation is a specific goal, but for any development programme that has one of the following characteristics:

- Where climate shocks or climate change could affect the outcomes of an intervention. Many of DFID's strategic priorities are climate-sensitive – for example, improving food security in Sudan.
- Where the programme could affect the vulnerability and resilience of local communities, either directly (for example, improving the management of shared water resources across Africa) or indirectly.

Studies suggest that the proportion of development portfolios that are at risk from climate change could be large. For example, the OECD estimated that US\$0.5 billion in international aid to Bangladesh and Egypt are at risk. A review by the World Bank estimated that 25% of its portfolio across six countries is at significant risk from climate change.

Activities today can have long-lasting impacts, which are difficult to reverse. The wrong types of interventions today can lock societies into a more vulnerable development path. In addition, a failure to account for uncertainties related to climate change can lead to wasted investments; for example, if new infrastructure like irrigation systems needed to be replaced or expensively retrofitted before the end of their useful lifetime, or could put more people at risk. For DFID, this could mean the failure to achieve its objectives, a lower value for money of investments and reputational damage. This gives a strong rationale for ensuring that programmes and projects are robust to climate change. DFID has committed a budget of £2.9 billion to the International Climate Fund (ICF), of which around half is allocated to adaptation. Yet this represents only around 3% of the UK's Overseas Development Assistance (ODA). There is a need to ensure that the other 97% is climate-resilient too.

Tackling climate change and its uncertainties will require a more forward-looking, proactive, flexible and progressive approach to programming. A resilient intervention is not



only one that is able to achieve its objectives today, but also one that is *robust*, meaning that it performs well under a wide variety of futures, and *adaptive*, meaning that it can be adapted to changing (unforeseen) future conditions.

Uncertainty over future climate will not necessarily be a factor in many development decisions. Development professionals deal with high levels of uncertainty every day. The difference here is perhaps that we know enough to be able to design interventions that are resilient to long-term changes. Uncertainty over future climate could be an important factor where an intervention is long-lived, inflexible (not adjustable) and high-stakes (with high costs and benefits). This will include, for example, interventions concerning buildings and infrastructure, urban development, sectoral growth strategies or land-use planning.

There are many places where it makes sense to invest early in adaptation, even though the benefits will not be felt until later. Similarly, in some cases, the most rational cause of action will be to wait until more information is available. The timing of adaptation interventions is an important consideration and will not only be determined by the risks to be avoided and the uncertainty, but also by the costs of delay (linked to the lifetime, reversibility of the intervention or its absence). The most urgent measures tend to be where not acting today can commit us to greater costs and risks in the future, for example: long-lived infrastructure and urban development.

We can draw out four priority areas for adaptation today:


- **Measures with early and robust benefits:** ‘Low-regrets’ measures, like climate-resilient development, early warning systems and insurance, for example.
- **Acting to avoid locking-in long-term risks:** taking action to account for changing risks in long-term decisions such as critical infrastructure, urban development, land-use change or sectoral development strategies.
- **Capacity building:** building the capacity for implementing development programmes that are resilient to the changing environment.
- **Low-regrets measures with long lead times:** for example, investing now in long-term agricultural research programmes to increase future options.

Adaptation and climate-resilient development are not substitutes – both are needed.

Development and poverty alleviation themselves can help to reduce vulnerability to climate impacts. But, there are a number of arguments for prioritising some specific and additional adaptation measures to cope with future climate today, such as accounting for climate change in long-lived infrastructure and urban development planning, tackling immediate risks from climate, and preparing for transformational adaptation where necessary.

There is evidence of a general lack of forward-looking interventions that anticipate future risks and act to reduce them ahead of time. A number of recent reviews of development portfolios suggest that the majority of so-called ‘adaptation’ interventions today focus on low-regrets measures and capacity building, and are failing to address the need to avoid locking-in risk. In addition, the application of tools to screen climate risks appears to be ad hoc and, as a result, climate risks are sometimes neglected in development programmes.

Implementing progressive and flexible interventions may raise institutional challenges for development organisations like DFID, where project timescales are relatively short and value for money must be demonstrated quickly. In addition, monitoring and evaluation frameworks may need to evolve from a backward-looking process, to become an integral part of the management of the project.



New capacities, both human and institutional, will be needed to help us adapt under uncertainty. We know what robust adaptation should look like, but we need to build capacity in applying the building blocks within development programmes. For example:

- In conditions of deep uncertainty, our conventional economic appraisal tools break down – alternative tools are available but require new skills, as well as resources to develop practical experience.
- We will need to better communicate the role of ‘robustness’ alongside conventional ‘optimisation’.
- Institutions and decision making processes will also need to evolve to deliver more long-term, incremental interventions, which can be adjusted over time as new information is gathered.
- There are several practical challenges to communicating and acting on uncertainty on the ground. For example, officials tend to be less willing to prioritise investments where the uncertainties are high and the options more disputed. Also, historically, planning and policymaking are often slow to react to, learn from and foresee change.

Frequently asked questions

1. Isn't adaptation just good development?

Adaptation *should* be just good development, but in practice traditional development alone is unlikely to meet short-term adaptation needs. Therefore, there is a rationale for investing in specific adaptation measures now. For example:

- Firstly, in an ideal world, investments in core development will build the capacity to adapt to climate change, but in practice there are many barriers to be overcome;
- Secondly, traditional development and growth, without considering climate change, could commit a society to a more vulnerable development path
- Thirdly, some specific adaptation measures are needed, for example, retrofitting some public infrastructure, building sea walls or investing in agricultural research; and
- Finally, some adaptation is urgent and there are high costs associated with delay.

These issues are discussed in more detail in Sections [1.1](#) and [1.3](#).


2. How do I know if future climate uncertainty should be an important factor in my decision?

There are generally three types of interventions where future climate uncertainty is likely to be an important factor in design and implementation:

- Firstly, where the intervention aims to support climate change adaptation;
- Secondly, where an intervention has outcomes that are climate-sensitive (for example, particularly those relating to agriculture, water, forestry, disasters or ecosystems); and
- Thirdly, where an intervention could directly or indirectly adversely affect the long-term vulnerability or resilience of a community, region or country (for example, urban development, natural resource management, land use change or sectoral development).

But, for each of these, climate change is only likely to be a factor if:

- The lifetime of the decision is long (where the lifetime is the full duration of influence, not just the length of the project);
- The decision is difficult or costly to change later (for example, a building may be difficult to retrofit later and urban development may be impossible to change); and

- 
- Where the intervention is costly or has significant implications, for example, in terms of the number of people affected.

These topics are covered in Sections [I.2](#) and [II.2](#).

3. How can we adapt while projected future changes remain so uncertain?

This is a common question in response to the emphasis on uncertainty in the scientific literature and to a focus on distant future impacts. In fact, long-term uncertainty is rarely an important factor in the decisions we make today because:

- Firstly, compared with normal weather variability or other factors in development decisions, such as political decisions or exchange rates, short- to medium-term climate is not so uncertain;
- Secondly, our attention should be focused on decisions being made in the near future and these types of decisions can be far more certain, even where there is uncertainty over the long-term climate. When the adaptation challenge is reconceptualised in terms of its implications for near-term decisions, many decisions are not so greatly affected by climate change;
- Thirdly, even where decisions are sensitive to assumptions about future climate, like long-lived infrastructure, there are many well-known approaches for reducing the risks in decision making; and
- Finally, not all adaptation needs to be done now – adaptation is not a one-off. Adaptation is a process in which decisions can be updated and improved as the future unfolds, and as more information is gained.

Therefore it is quite possible to make decisions in the face of uncertainty anyway. Further details are given in Sections [II.2](#) and [III.1](#).

4. I have limited resources. How do I ensure that my programme is resilient to climate change?

The first stage is to identify if climate change and uncertainty are important factors in the design of the programme, either qualitatively (Section [II.2](#)) or quantitatively (Section [IV.2](#)). In many cases, climate change will not be important. If climate change is an important factor, consider approaches to reduce the impact of uncertainty on the outcomes of the intervention (Section [III.1](#)). Decision analyses are then used to estimate whether a strategy meets certain criteria and to weigh up different options. These analyses need not be complicated – they can start with simple sensitivity testing and scenario analyses. Complex and resource-intensive decision analyses will generally only be needed when the decision is highly sensitive to uncertainties – e.g. for long-lived, high-stakes and irreversible decisions like the design of a new dam – and where the costs of delaying action are high.



SECTION I Climate change, adaptation and climate-resilient development: an overview

“If we are serious about development we need to be serious about climate change”, Mark Lowcock, Permanent Secretary, DFID, 2011

“The two defining challenges of the 21st century are overcoming poverty and avoiding dangerous climate change. If we fail on one of them, we will fail on the other”, Lord Nicholas Stern, I G Patel Professor of Economics and Government, London School of Economics and Political Science, 2009

Development and climate change adaptation are intimately linked. The poorest and most stressed people tend to be worst affected by climate impacts and will have the least capacity to respond to climate change. Today, the climate already has a material impact on the development prospects of the poorest countries. Since 1980, weather catastrophes alone have caused almost 1.2 million fatalities and led to direct damages amounting to US\$610 billion in low and lower-middle income countries¹.

Climate change will affect climate ‘shocks’, like droughts, floods and storms, but will also lead to more gradual changes in climate (climate ‘stress’). Firstly, climate change is expected to increase the intensity of climate shocks. For example, the global land area affected by drought is expected to rise and tropical storms are likely to become more intense (IPCC 2012). Secondly, more gradual changes in climate will increasingly stress poverty alleviation and development goals through their direct and indirect impacts on human health, food systems, water supplies and ecosystems (World Bank, 2010a).

Climate impacts will interact with other threats and pressures, such as population growth, increasing resource scarcity, environmental degradation, conflict and instability, magnifying their impacts. The 2013 Global Risk Report of the World Economic Forum ranked a failure to adapt to climate change as the greatest environmental risk faced by humanity, and amongst the top 10 most interconnected global risks (Fig. I.1). This risk has strong interdependencies with the risks of food and water crises, unsustainable population growth, global governance failures, volatile commodity prices, mismanaged urbanisation and species overexploitation (WEF, 2013).

Without appropriate interventions, climate change will create a vicious circle of growing vulnerability and impacts. The poor could be driven deeper into poverty and the development gains achieved by organisations like DFID may be short-lived. The progress made against the Millennium Development Goals is under threat (OECD, 2009)².

The only way to limit future climate change is to substantially reduce global greenhouse gas emissions. But the world is already committed to further warming and climatic change over the next 30 years or so due to past emissions. Adaptation is the only option to safeguard development and poverty alleviation gains from the effects of this unavoidable climate change.

¹ Data supplied by Munich Re.

² See Table 1.1 in OECD (2009) for further details (pg. 29).

- This means that if we don't take account of changing risk in our decisions today, the impacts of climate change on people and systems will continue to rise. This will erode the gains from development interventions and the value for money of investments will decline.
- A solution is to **adopt a more forward-looking and long-term approach in designing our development interventions and managing risks**. A challenge is that this is contrary to the way most development interventions proceed, where projects are short (three to five years) and the incentive is for rapid impact and return on investment (Jones et al. 2013). **We need to look ahead because in some cases, like long-lived fixed infrastructure, it is often cheaper and easier to take account of long-term risks upfront today than to make costly retrofits later**. In addition, **focusing only on the near-term could also commit us to greater and difficult-to-reverse risks down the line**. For example, mismanaged urbanisation, continuing to overexploit the natural environment and not tackling rising water demand today, lock us into a more vulnerable future.

Secondly, the speed and scale of changing risk could be greater than seen before.

- To date much of our climate risk management has been reactionary. For example, the Thames Barrier in London was built only after more than 300 people lost their lives in the 1953 floods. The consequences of not acting ahead of time are much greater where risk is increasing.
- **It is well known in the disaster risk management community that ex-ante action, acting ahead of time, not only saves lives but is cheaper in the long run** (IPCC, 2012). **Climate change strengthens the economic and social case for pro-active action**. Actions such as relocating people, changing behaviour, agreeing regulatory frameworks, building institutional capacity or diversifying our markets and supply chains will take time and so we need to think and act ahead.

Finally, future risks are deeply uncertain.

- While we know a lot about how the climate will change in the future, we cannot predict exactly how climate change will affect the risks to a particular community, or the outcomes of a particular intervention. If we do not account for uncertainty fully and properly in decisions today, it can lead us to take the wrong choices – for example, too many, not enough, or the wrong types of risk management measures, which will lead to greater costs, wasted investments and bigger risks down the line. These would occur, for example, if new infrastructure like roads, irrigation systems and reservoirs needed to be abandoned, replaced or expensively retrofitted before the end of their useful lifetime. Such maladaptation can have long-lasting and difficult-to-reverse impacts on the people they are intended to help (Barnett and O'Neill, 2010).
- **Uncertainty means that we need an approach to development that is as robust and adaptable to current and future climate as possible** – this means designing plans that are flexible and progressive.

It is these three challenges that we aim to address in this Topic Guide. Specifically we explore how to design interventions that reduce vulnerability and build resilience (Fig. [1.2](#)) in ways that are more forward-looking, pro-active, flexible and progressive (Section [III.1](#)). We also consider the implications for the timing of adaptation (Section [III.2](#)), the appropriate resource allocation between adaptation and climate-resilient development (Section [1.3](#)), the prioritisation of different investments (Section [III.3](#)) and the appropriate tools for options appraisal (Section [IV](#)).

The remainder of this section aims to address the following questions:

1. *Why are the least developed countries typically more vulnerable and less resilient to climate shocks and stresses, and what are the main drivers?*
2. *What are the relationships between development, disaster resilience and adaptation?*
3. *What are the practical implications for aid organisations like DFID?*

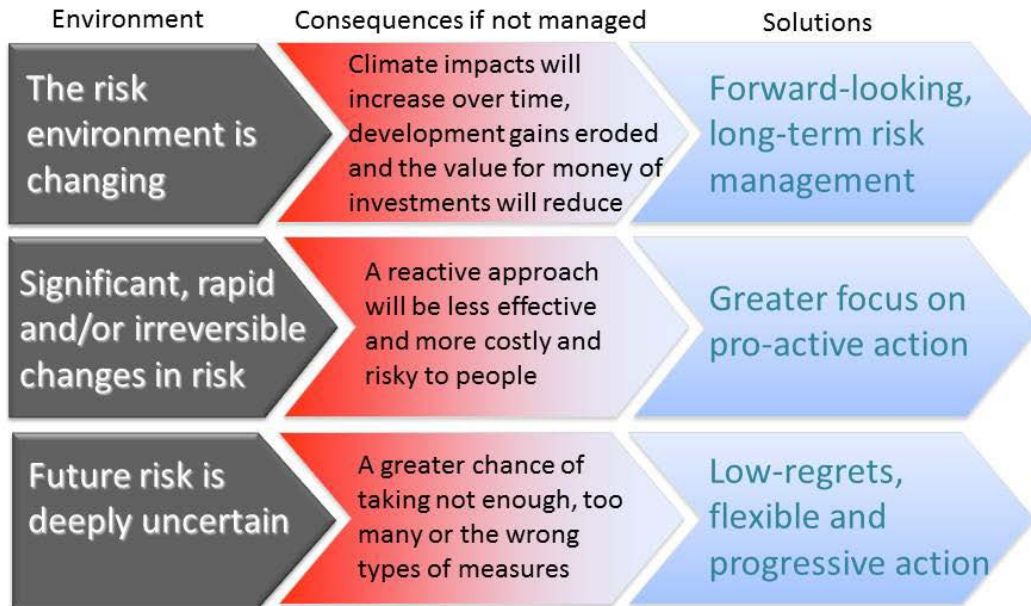


Figure I.2: The challenges of adaptation decision making. Source: based on Ranger and Garbett-Shiels (2012) and Fankhauser et al. (2013)

Case Study 1: Agriculture in Sub-Saharan Africa (SSA) in a 4°C-plus warmer world

Agriculture is an economic mainstay of many SSA countries, employing on average about 60% of the workforce. The prevalence of malnourishment has declined, but very slowly, to around 30%. In the future, SSA will see the combined pressures of changing food demand and a more hostile climate.

The complexity in climate–crop systems, together with the limits to the predictability of the climate, lead to significant uncertainties in predictions of future yields. One study predicts that the average length of the growing season could decline across much of SSA (except East Africa). It suggested that by the 2090s in Southern Africa nearly all rain-fed agriculture is likely to fail one year in two. This prediction appears relatively robust (except in the south west). Yields of key crops like maize and beans could decline across SSA by, on average, 24% and 71% respectively by the 2090s, but there is much uncertainty about the exact scale of declines. The implications for food security are more difficult to predict, requiring predicting the interactions with broader development and market trends.

Adapting to these impacts will require radical shifts in agricultural systems, rural livelihood strategies and food security strategies and policies. Despite the uncertainties, there are a number of robust adaptation programmes that could be implemented in the short term. These include, for example, empowering vulnerable local communities, strengthening institutional support for innovation, access to markets and agricultural extension, improving meteorological services and enabling diversification. Other valuable activities include research and monitoring; exploiting global stocks of crop germplasm and livestock genes; and addressing the social, economic and political processes that contribute to food insecurity, including international reforms. However, by the 2090s it is possible that some areas could come up against physical or social limits to adaptation. Further research is needed to map out where these hard limits lie and explore the implications for decisions we make today.

Sources: Thornton et al. (2011) and references therein



I.1. Introduction to vulnerability, resilience and adaptation

The impacts of climate shocks and stresses are driven not just by the characteristics of climate to which a society is exposed, but also, more importantly, its vulnerability and resilience to climate. The terms vulnerability and resilience are defined in different ways by different people and are sometimes used interchangeably. Most experts would agree that the impact of a given climate shock or stress is driven by four factors: the sensitivity, exposure, recoverability and adaptive capacity of a society or system, as described in Fig. I.3.

We define *vulnerability* as the overall susceptibility to harm at a given point in time, which is determined by the social, demographic, infrastructural, environmental, institutional, economic and cultural state of a society or system and underlying development and risk management trajectory (Matyas and Pelling, 2012). By contrast, *resilience* is the capability to withstand sudden shocks, recover from crises when they occur and adapt to changing circumstances (Howell, 2013). The terms are therefore interrelated but resilience is more concerned with the ability to take action, rather than the current state of a system or society, and is linked with governance and capacity (human, technical, institutional and financial).

The poorest communities tend to be more vulnerable and less resilient to shocks and stresses (climate or otherwise). For example, poorer communities tend to be located in more marginal areas, such as low-lying areas or areas with poorer growing conditions. They may also have livelihoods that are more dependent on climate-sensitive production, such as rain-fed agriculture, forests and fisheries. Hence their exposure to climate is greater. Poorer communities also tend to be more sensitive to climate as, for example, investments in risk reduction are lower, governance is weaker, and public services, such as public health care and social safety nets, are less comprehensive. People may also already be under stress from other factors, such as poverty, environmental degradation, resource scarcity, food insecurity, water stress and conflict. There is less capacity to respond to events when they occur and to adapt to future climate due a lack of available resources and governance capacity (e.g. IPCC [2012] and references therein).

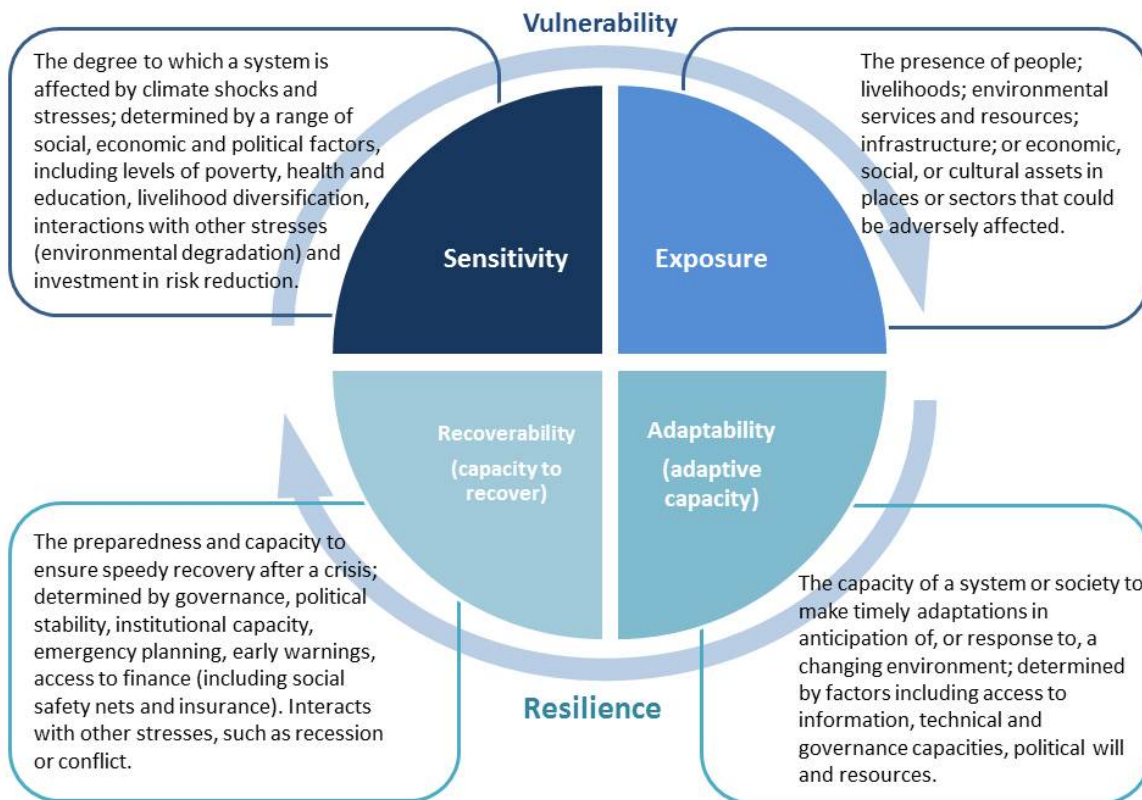


Figure I.3: The four components of vulnerability and resilience to climate. Based on Adger et al. (2007), IPCC (2012) and Howell (2013)

Adaptation aims to lessen the impacts of climate stresses and shocks through reducing the vulnerability of human and natural systems to its effects, enhancing resilience and through capturing any opportunities (Fig. I.4).

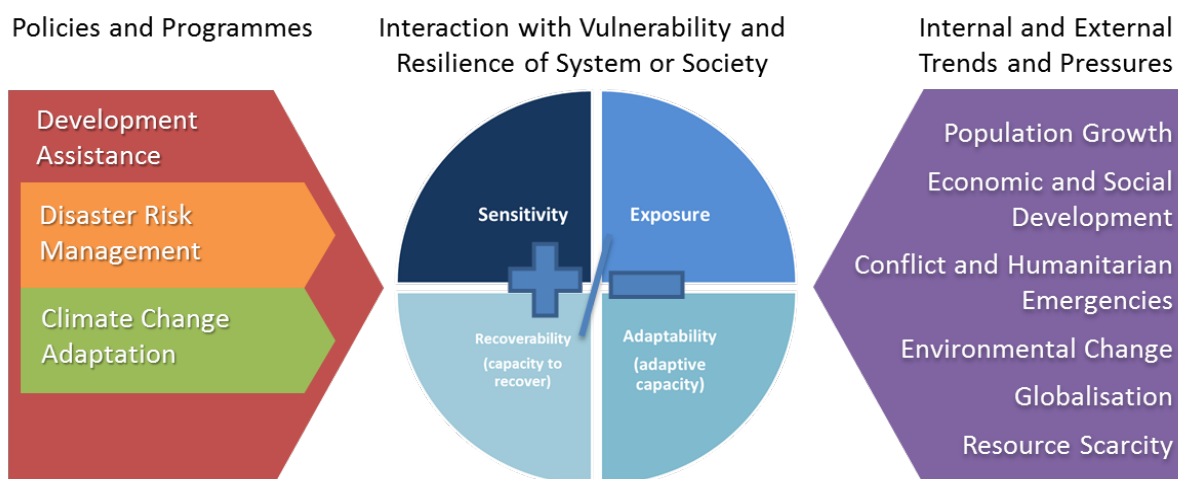



Figure I.4: The influence of development, adaptation and disaster risk management, and external and internal change factors, on the vulnerability and resilience of a system or society



However, vulnerability and resilience are dynamic and are influenced by many internal and external factors over time. For example, conflict may reduce the capacity to recover from shocks and prepare for climate change; environmental degradation and resource scarcity may increase sensitivity to climate; and population growth could increase exposure.

Development and poverty alleviation can also reduce vulnerability and build resilience to climate change. For example, traditional development programmes, such as those improving health care, diversifying livelihoods and supporting education, can reduce sensitivity, while strengthening governance and institutional capacity enhances the capacity to recover from climate shocks and adapt to climate change (World Bank, 2010a). Disaster risk management, a core component of development, is largely synonymous with adaptation⁵.

Development, disaster risk management (DRM) and climate change adaptation can therefore be considered to be three interdependent and mutually reinforcing policy goals (Fig. 1.5). Development is an enabler of adaptation and DRM and vice versa (Mitchell, 2012).

But there can be trade-offs between these policy goals. Not all development will necessarily reduce vulnerability. The wrong types of interventions today can lock societies into a more vulnerable development path for decades to come. For example, an intervention that promoted water-intensive agriculture would be detrimental if the climate became drier over time, but could be difficult to reverse (e.g. if indigenous knowledge and technologies were lost). Similarly, an intervention that incentivised migration to cities in coastal regions could put more people at risk from coastal flooding. Building schools and hospitals that were not adapted to climate change could increase vulnerability in the future.

⁵ The difference is that adaptation concerns reducing the impacts of climate shocks and gradual climate change, whereas DRM concerns only shocks and encompasses all disasters.

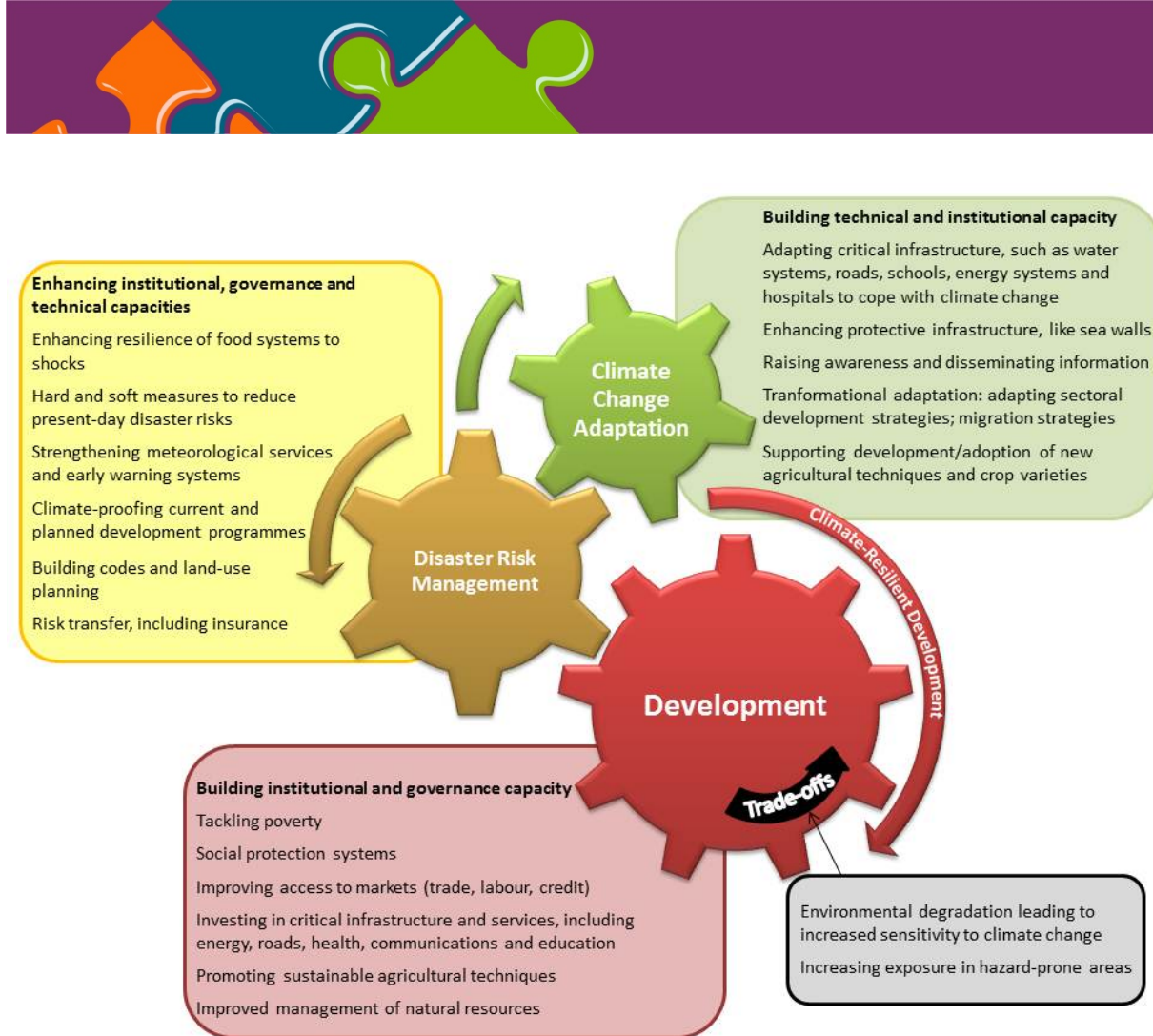


Figure I.5: Development, adaptation and disaster risk management as three interlinked policy goals, with examples of policies and programmes for each

Studies have identified a number of ways in which development strategies may need to change to facilitate adaptation (Vivid Economics, 2010):

- **Greater focus on management of natural resources**, including water, soils, air and ecosystems, with emphasis on promoting long-term sustainability and resilience;
- **Increasing emphasis on DRM**, to reduce current and future vulnerability to climate variability and shocks;
- **More awareness of near-term and long-term risks in policy making, including recognising potential maladaptations.** This would involve mainstreaming DRM and adaptation into all development activities, from national planning to local-level projects. Examples include recognising that policies to incentivise businesses to maximise productivity and growth can expose poor people to unacceptable risks (e.g. over-intensive agriculture), and that urban developments in hazard-prone areas lock in vulnerability to climate shocks and climate change;
- **Institutional capacity building** to support development that is robust and adaptable to changing climate conditions, including appropriate leadership, training, champions and institutional structures and processes;
- **Regulation and price incentives to encourage climate-resilient development in the public and private sector**, for example, regulation of building standards, engineering standards for new public infrastructure, enhanced land use planning, water efficiency programmes and regulation of utilities companies to ensure they include climate change in their long-term planning; and

- **Providing public goods with co-benefits for DRM and adaptation** (Cimato and Mullan, 2010), such as emergency services, investing in meteorological services, social safety nets and research into new medicines and agricultural technologies.

These policies reflect the more forward-looking and pro-active approach to development and risk management that is needed for adaptation (Fig. 1.2).

Collectively, these policies build the foundations for *climate-resilient development*, which means ensuring that development proceeds in a way that enhances the resilience of a society and does not inadvertently increase vulnerability of communities in the long run. This is synonymous with *sustainable development*, which is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987).

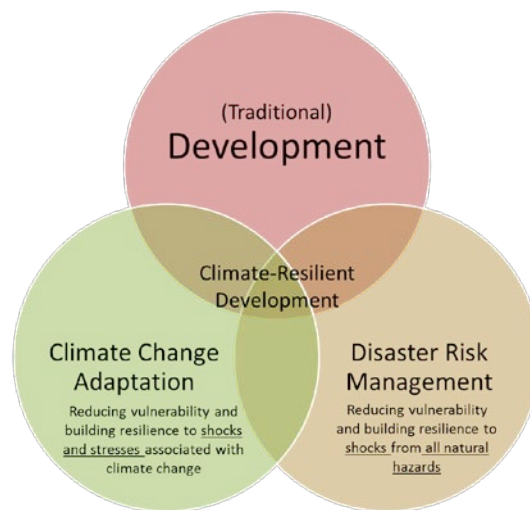


Figure 1.6: The relationships between development, adaptation and disaster risk management

Climate-resilient development could be considered to be the overlap between traditional development, climate change adaptation and DRM (Fig. 1.6). The separation between these three activities in Fig. 1.6 is somewhat artificial, as adaptation and DRM *should* be part of ‘good’ development. However, their separation reinforces the important point that effective adaptation is more than just traditional development. Measures to deal explicitly with climate shocks and climate change will be required (OECD, 2009).

Many other development policy goals (or cogs in Fig. 1.5) have synergies and trade-offs with adaptation. For example, there is evidence that empowering women in developing countries can help to reduce their vulnerability to climate shocks; while ignoring gender concerns in adaptation can reinforce the greater vulnerability of women (Adger et al. 2007). Economic growth literally buys options to reduce sensitivity, including better protection, natural resource management and institutional capacity (OECD, 2009), but can have trade-offs if it is not climate resilient, sustainable and pro-poor (Dercon, 2012).

I.2. Adaptation and climate-resilient development in practice

Climate change and climate-resilient development are recognised as crucial issues for DFID. DFID has committed a budget of £2.9 billion to the International Climate Fund (ICF) between April 2011 and March 2015, of which around half is allocated to adaptation.

This follows an investment of £1.5 billion to Fast Start Finance for 2010 to 2012 pledged under the UN Framework Convention on Climate Change (UNFCCC). The overarching vision for the UK's approach to adaptation is that *“vulnerable people in poor countries are prepared and equipped to respond effectively to existing climate variability and the magnified impacts of climate change”*.

Yet the ICF finance represents only 3% of the UK's Overseas Development Assistance (ODA). There is a need to ensure that all ICF investments and the remaining 97%, or roughly £8.4 billion per year of ODA, is also climate-resilient. Climate change will be a relevant risk and uncertainty for many development interventions, not just those labelled as adaptation. It is central to achieving many of DFID's strategic priorities. There are two dimensions to this (Box I.1)⁶.

1. **Climate shocks and climate change will affect the success, and broader outcomes, of some development programmes.** Many of DFID's strategic priorities outside of the ICF are 'climate-sensitive'. For example, the long-term success of programmes designed to support the strategic goal to increase food security in Sudan may partly depend on how the climate of the region evolves over the next decade or more. Programmes must therefore be designed such that this goal can be met irrespective of how the climate changes (Fig. I.7); and
2. **Development programmes could enhance or inadvertently constrain the resilience of local communities.** DFID programmes are likely to influence the sensitivity, exposure, recoverability and adaptive capacity (Fig. I.2) of local people, either directly (e.g. improving the management of shared water resources across Africa) or indirectly (enhancing access to credit in Tajikistan).

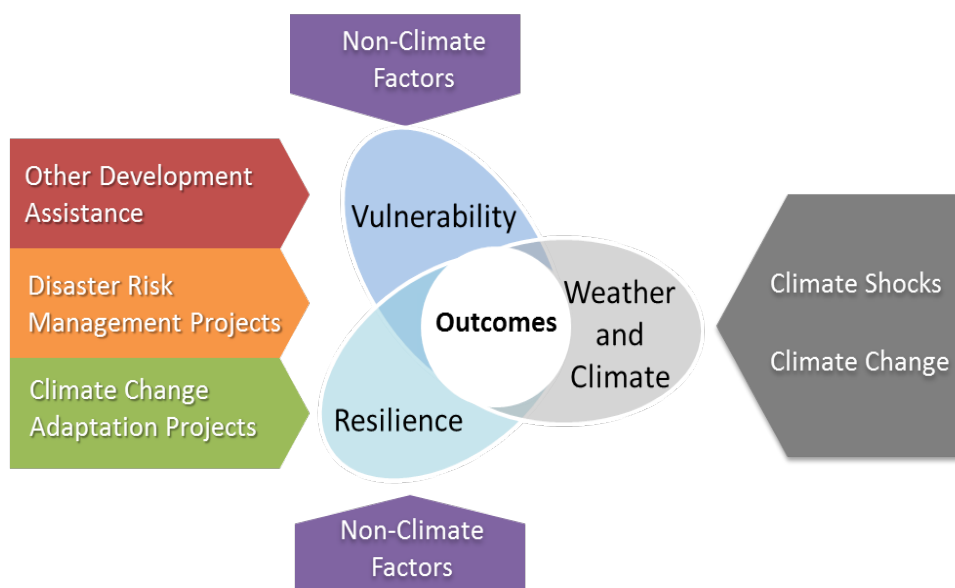


Figure I.7: Interplay of development programmes, climate and non-climate factors (like urbanisation and resource scarcity) in determining the vulnerability and resilience of a society and the outcomes of development programmes. Adapted from IPCC (2012)

⁶ Examples from the Sudan, Africa Regional and Central Asia Operational Plans 2011-2015.

Box I.1: Typology of decisions

We have explained that development interventions may influence vulnerability to climate change in two main ways. Firstly, the intervention can affect the vulnerability or resilience of local people to climate shocks and climate change. Secondly, climate change can affect the success or value for money of an intervention. The table below illustrates how this might come about.

For example, restoring mangroves is 'positive' against the first category (horizontal in table), because it enhances the resilience of local communities to shocks and climate change. It is also 'positive' against the second category (vertical in table) because climate change could actually increase the value for money of the investment.

Conversely, introducing rain-fed agriculture in a region of declining future rainfall could be 'negative' against the first category, because it could make people less resilient to rainfall variability, and 'negative' in the second category, because the value for money of the investment would decline if rainfall levels reduced.

Effect of intervention on vulnerability and resilience to climate shocks and climate change

| | | Negative | Negligible | Positive |
|---|------------|--|--|--|
| Effect of climate change on success or value for money of an intervention | Negative | The introduction of rain-fed agricultural strategies in a region of declining rainfall | | Access to drought-resistant crops enhances resilience, but in regions expected to see fewer droughts will have a lower value for money |
| | Negligible | Urban economic development that encourages poor workers into vulnerable informal settlements | Implementing earthquake building codes to new buildings in Nepal | Reducing corruption will enhance economic efficiency and governance capacity and so increase resilience to climate |
| | Positive | Afforestation programmes that reduce flood risks to farmers downstream but reduce groundwater supplies to upland farmers | | Restoring mangroves reduces the sensitivity of local people to storm surges. This protection will have a higher value for money as storm intensity increases |

A number of studies have reviewed the climate change risks to the portfolios of development agencies retrospectively (Gigli and Agrawala, 2007; Klein et al. 2007). For example, the ORCHID project identified a large number of DFID projects with climate-sensitive outcomes and where there were opportunities to build in greater climate resilience⁷. Burton and van Aalst (1999) estimated that up to 62% of the World Bank's investments in six countries were sensitive to climate change. A later review of projects concluded that 25% of World Bank projects are at significant risk from climate change (World Bank, 2006). An OECD analysis (van Aalst and Agrawala, 2005) assessed all official aid flows from all donors to six developing countries and found that US\$0.5 billion in flows to Bangladesh and Egypt, and about US\$200 billion to Nepal and Tanzania over 1998 to 2000 were at risk from climate change.

⁷ The ORCHID project was a DFID-funded research programme that developed applied screening tools to identify the climate vulnerability of DFID country programmes, including India, China and Bangladesh. See: <http://www.ids.ac.uk/climatechange/orchid>



These risks associated with climate change will need to be managed or ‘mainstreamed’ at multiple levels of decision making and development programming: from national-level policies and plans, to sectoral development plans, local-level governance and community action and specific projects (OECD, 2009). Figure I.8 illustrates potential entry points for climate change to be mainstreamed into decision making within a country. The interventions appropriate at each stage of the policy cycle will be very different – from ensuring the climate resilience of long-term policy at the national level to climate-proofing specific project proposals at the local level.

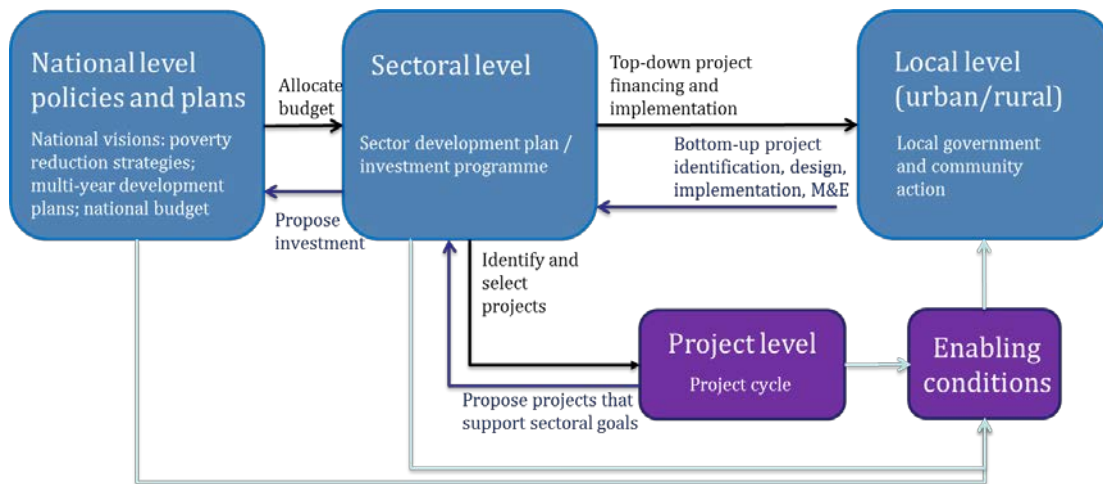


Figure I.8: Decision levels influenced by climate change. Source: reproduced from OECD (2009)

For a development organisation like DFID this means that climate change will influence:

- *Operational plans*: operational plans set out what results will be achieved and when by spending departments. In country offices these are developed in consultation with recipient countries. Climate change will influence who, what and where development assistance is most needed, as well as the achievability of other development objectives (concerning, for example, food security), so could influence the strategic priorities set out in the plans;
- *Country-level portfolio management*: portfolio management concerns the allocation of resources across programmes and projects to meet the targets laid out in the operational plans. Climate change could impact the allocation of resources, for example, targeting greater investment towards priority adaptation needs (Section III.3);
- *Specific projects/interventions*: to design interventions that are effective and robust to future climate conditions, climate change must be considered at the start of the *business plan* process (Section III). Climate change and uncertainty will also have a bearing on the way that interventions are implemented, and the role and design of the *monitoring and evaluation* process (Sections III.1 and III.2);
- *Relationships with other funders and MLFIs*: DFID has an opportunity to influence the UK ODA delivered through multilateral finance institutions (MLFIs), such as the World Bank and regional development banks, including the prioritisation of investments, budget allocations and project design to ensure that interventions are robust and adaptable to climate change. It can also share good practice in risk screening and monitoring and evaluation; and
- *Policy*: climate change impacts will be a risk to the success of policy frameworks, like the Post-2015 Development Agenda. But if designed well, such policy frameworks can support reductions in climate-change risks through promoting appropriate action.

Climate change and climate-resilient development will be relevant at all levels of DFID decision making, from project management, to programme business cases, to portfolio level allocations of resources. This is not limited to decisions where climate resilience is a strategic objective. Officials should ask whether their policy or intervention might affect the vulnerability to climate change, or whether climate change could affect the outcomes of the project, at the outset of the process⁸.

I.3. Balance of effort between adaptation and climate-resilient development

An issue of much debate is the appropriate allocation of resources between climate-resilient development and *specific and additional* adaptation. Climate-resilient development is often easier to ‘sell’ to policymakers, as it has co-benefits that meet short-term priorities of eradicating poverty, enhancing food security and economic growth. It also has the advantage of treating the *underlying drivers of vulnerability*, rather than its symptoms. Some experts have argued that, for the poorest countries, the main focus should be on climate-resilient development (Fig. I.9).

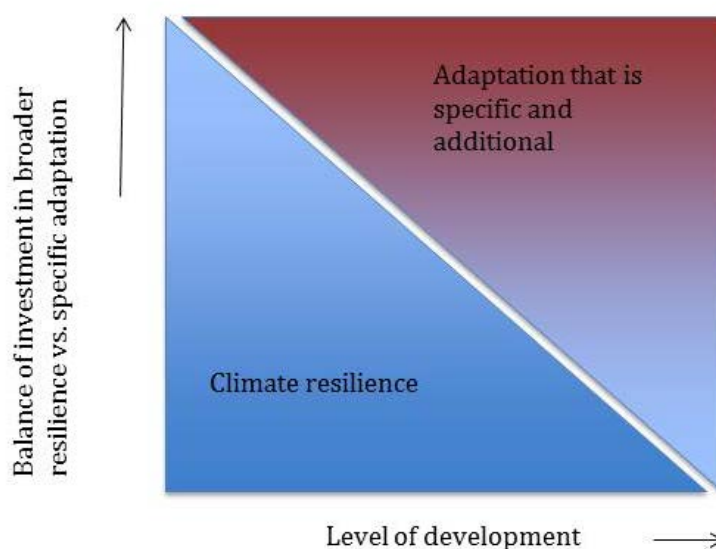



Figure I.9: The ‘balance of effort’ model. Source: Tanner et al. (2012)

Yet there are a number of arguments for prioritising some *specific and additional* adaptation measures to cope with future climate today (Stafford-Smith et al. 2011; Ranger and Garbett-Shiels, 2012). Climate-resilient development, as defined here, primarily focuses on reducing social and economic sensitivity to climate as well as building recoverability and adaptive capacity for a range of shocks and stresses through advancing development. But to adapt effectively to climate change will require a more forward-looking and pro-active approach to risk management (Fig. I.2). This will include some specific measures, like retrofitting infrastructure, providing climate information, raising defences and investing in research.

Arguably, investments in development will increase the capacity of countries to implement such programmes in the future. However, in some cases there are advantages to acting now

⁸ DFID has a corporate compliance commitment to assess all interventions for their relevance to climate change and environment. See DFID’s ‘Climate and Environment – How to Note’ for further information (available on Insight).



to address the challenges outlined in Section [1.2](#) by making specific and additional adaptation investments:

- Firstly, for investments that are long-lived or have long-term consequences, it is often cheaper and easier to account for long-term climate up front, or within the natural replacement cycles, rather than retrofitting later;
- Secondly, if climate change is not accounted for specifically in development decisions today then they risk committing societies to a more vulnerable development path;
- Thirdly, in some areas there are already significant climate-related risks that require response. For example, in Nepal action is needed to avoid and protect against potentially catastrophic glacial lake outburst floods that are already a major risk and where risk is expected to increase with rising temperatures (Agrawala et al. 2003); and
- Finally, adapting to significant changes in climate could require transformational changes in social and economic systems (Stafford-Smith et al. 2011), such as diversifying away from some sectors, and this can require decades to plan and implement.

There are many other open questions about implementing adaptation in practice. The remainder of this Topic Guide focuses on the particular challenge of climate uncertainty. In this Topic Guide, we argue that this uncertainty need not be a barrier to implementing effective development programmes today. Development programmes deal with risk and uncertainty every day and in only a few cases will climate change uncertainty be an important factor in the decision. Even in such cases, it is normally possible to design programmes in ways that make them robust to uncertainty. This is discussed in Section [III](#). In the following section (Section [II](#)), the Topic Guide provides an overview of the types and sources of uncertainty and the implications for decisions today.



Key messages from this section

- **Climate change adaptation brings a number of unique challenges for development professionals, requiring a more forward-looking, pro-active, flexible and progressive approach in development programmes.**
- **Climate change and climate-resilient development are recognised as crucial issues for development organisations and will have implications at all levels of planning and implementation, from operational plans to individual projects.** It is relevant not only for programmes where adaptation is a specific goal, but for any development programme that has one of the following characteristics:
 - Where climate shocks or climate change could affect the outcomes of an intervention. For example, experts have concluded that the progress made against the Millennium Development Goals is under threat.
 - Where programmes could affect the vulnerability and resilience of local communities, either directly or indirectly.
- **Development is an enabler of adaptation and vice versa but there can be trade-offs between these policy goals.** Development, disaster risk management and climate change adaptation can be considered to be three interdependent and mutually reinforcing policy goals. But the wrong types of interventions today can lock societies into a more vulnerable development path for decades to come. Climate-resilient development aims to ensure that development proceeds in a way that enhances the resilience of a society and does not inadvertently increase vulnerability of communities in the long run.
- **Adaptation and climate-resilient development are not substitutes – both are needed.** Climate-resilient development is often easier to ‘sell’ to policymakers, as it has co-benefits that meet short-term priorities of eradicating poverty, enhancing food security and economic growth. Some experts have argued that, for the poorest countries, the main focus should be on climate-resilient development. But there are a number of arguments for prioritising some specific and additional adaptation measures to cope with future climate today, such as accounting for climate change in long-lived infrastructure and urban development planning, tackling immediate risks from climate, and preparing for transformational adaptation where necessary.



Where can I find more information?

DFID resources:

- DFID Practice Paper “Climate-Resilient Growth: preparing growth strategies for climate change – how to note”. November 2010.
- ICF Thematic Paper on Adaptation.

External papers:


- “*World Development Report 2010: Development and Climate Change*” World Bank (2010). Good introductory text. An accessible account of the linkages between climate change and development, and a detailed discussion of the implications for development interventions today from the local level to international finance and policy.
- “*Integrating Climate Change Adaptation into Development Cooperation*” OECD (2009). A detailed but accessible report on the role of climate change adaptation in planning at the project, sector and national levels, including specific and detailed guidance on incorporating climate change into development cooperation. It also provides useful descriptions of the linkages between adaptation and development and the potential implications of climate change for developing countries, including the achievement of the Millennium Development Goals. This report is linked with an online course.
- “*Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*” Agrawala and Fankhauser (2008). An accessible but slightly more technical report on the economic costs and benefits of adaptation and the policy toolkit available.
- “*Stock taking of progress on integrating adaptation to climate change into development cooperation activities*” (Gigli and Agrawala 2008). A review of the status of development agencies’ process on adaptation.
- World Resources Report: <http://www.worldresourcesreport.org/wrr-2010-2011>

Online lectures and courses:

- Vicki Arroyo: “*Let’s prepare for our new climate*”. Basic introduction video to climate change adaptation with examples from both developing and developed countries. http://www.ted.com/talks/vicki_arroyo_let_s_prepare_for_our_new_climate.html
- Institute of Development Studies interactive briefing on “*Learning to Tackle Climate Change*” <http://www.ids.ac.uk/publication/learning-to-tackle-climate-change>
- OECD online training on integrating climate change adaptation into development planning: <http://www.oecd.org/environment/environment-development/integratingclimatechangeadaptationintodevelopmentplanningapractice-orientedtrainingbasedontheoecdpolicyguidance.htm>

Knowledge-sharing platforms and archives of case studies:

- Climate and Development Knowledge Network: <http://cdkn.org>
- Adaptation Learning Mechanism: www.Adaptationlearning.net
- WeADAPT: www.weadapt.org
- World Bank Climate Change Knowledge Portal: <http://sdwebx.worldbank.org/climateportal/index.cfm>



SECTION II Climate change and uncertainty and their implications for development decisions today

“Doubt is not a pleasant condition, but certainty is absurd”, Voltaire

This goal of this Topic Guide is to raise awareness about how to manage the changing and uncertain climate risks in development programming today. Many of the tools and concepts here are relevant to managing uncertainty about other long-term trends and risks.

If climate change and its uncertainties are not managed well from the outset of development programmes, this could mean that they fail to achieve their objectives, have a lower value for money or could create reputational damage. In Section [I](#), we learnt that climate change implies a fundamental change in the environment in which development interventions operate. This means that climate change needs to be accounted for properly in decisions today (not just in adaptation programmes but in all decisions that have a climate-sensitive component or that could alter societal vulnerability). Otherwise, the development gains from interventions could be short-lived or, in some cases, could lead to wasted investments or adverse outcomes – where their long-run impacts are more harmful than helpful.

This is not a cause for hopelessness: in many cases future climate uncertainty need not be an important factor in decisions today. In this section, we show a number of case studies where uncertainty is and isn't an important factor in decisions today.

However, it does mean that we need to take care to identify if and how future climate uncertainty is a factor and to design and implement interventions in such a way as to make them robust and resilient to the changing climate.

In reading this Topic Guide, it is important to remember that uncertainty itself is common across all development programmes. Development professionals deal with high levels of uncertainty every day. As the 18th-century philosopher Voltaire said, it is the idea that we have certainty that is absurd. The difference with climate uncertainty is that it is perhaps better understood and better characterised than other types of uncertainty, such as future political conditions or global trade patterns, and so we have the opportunity to design **more robust, adaptable and therefore, resilient development programmes**. The tools and concepts introduced in this guide will be relevant to managing all types of uncertainty.

In this section, we aim to address the following questions:

1. *How uncertain are climate and impact projections and where does this uncertainty come from?*
2. *Where will climate change be an important factor in development decisions today?*
3. *Where will climate uncertainty be important today?*

In this section, we focus on characterising the uncertainty, but the design of development interventions themselves can help to reduce uncertainty. This is the subject of Section [III](#).

II.1. What do we know about future climate change and its impacts?

There is much that we currently do know about how the climate will change over the coming few decades. For example, we know that the increase in greenhouse gas (GHG) levels in the atmosphere caused by human emissions will lead to warming across most of the Earth's surface. It is also clear that this will cause sea levels to rise and will change rainfall patterns, with wet areas tending to get wetter and dry areas tending to get drier. We also expect an increase in the intensity of many types of extreme weather.

But we do not know exactly by how much temperatures will rise over the coming decades, or exactly how weather conditions will change at the local level. The uncertainties become larger the further we try to predict into the future.

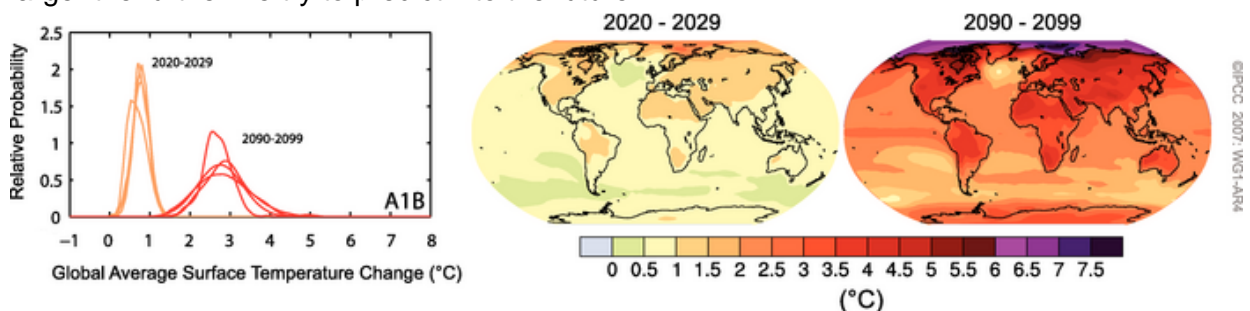


Figure II.1: Projected surface temperature changes for the early (2020-2029) and late (2090-2099) 21st century relative to the late 20th century (1980-1999). The left panel shows the uncertainty in global projections based on several different models. The right panels show the average level of warming projected by models across the globe. All projections are for a central emissions scenario (SRES A1B)

For example, the left panel of Fig. II.1 shows that by the 2020s, the Intergovernmental Panel on Climate Change (IPCC) concludes that globally temperatures are *likely* to rise by up to about 1.5°C above the levels observed at the end of the 20th century (1980 to 1999). In IPCC terminology, *likely* implies more than a two-thirds chance (>66%). Much of this warming is already locked in due to our past emissions so is insensitive to our assumptions about future GHG emissions (Solomon et al. 2007). As we look further ahead in time, the range of projections increases, as emissions scenario uncertainty and climate model uncertainty increases (Box II.1). For example, for the 2090s the IPCC projects that global temperature could increase to between 1.1°C and 6.4°C above 1980 to 1999 levels. About half of this range is due to uncertainty in the climate response and the other half due to the uncertainty about how GHG emissions will change over time⁹.

Uncertainties are greater for changes in rainfall and for predicting changes in extreme events, like flooding, droughts and storms. For example, Fig. II.2 gives the seasonal average rainfall projections that correspond to Fig. II.1. The white regions show areas where less than two-thirds of climate models agree even on whether rainfall will increase or decrease. Such areas of high uncertainty cover large parts of Africa, Asia and South America. For example, Ghana models predict anything from a 20% increase in rainfall to a 30% decrease (Hallegatte et al. 2012). This range of projections would raise fundamental problems for a hydraulic engineer trying to design a dam in Ghana or for a farmer trying to decide whether to invest in an irrigation system.

⁹ The business-as-usual emissions scenarios attempt to project how global emissions of several gases will change, assuming no specific policies to mitigate greenhouse gas emissions. For more information, see IPCC (2000).

Box II.1: Why are future climate projections so uncertain?

Climate projections are generated from climate models. These are computer models that attempt to simulate the physical processes of the climate system. They are similar to the models used to create weather forecasts¹⁰. Climate uncertainty can be divided into three types:

- **Forcing (or scenario) uncertainty:** uncertainties in our assumptions about how human emissions, GHGs and others (particularly aerosols), will evolve over time in response to changing population, technologies and socioeconomic developments, and changes in natural forcing, such as solar radiation and emissions from volcanoes;
- **Model uncertainty:** uncertainty that stems from gaps in our understanding of how the climate operates or in our ability to model processes sufficiently¹¹. This is an epistemic (or systematic) uncertainty, and could (in theory) be reduced as more is learnt and models become more powerful. Yet it is unlikely that we will see a narrowing of the uncertainty range in the next 10 years. The range of uncertainty is also impossible to quantify at present; for example, current climate models share a number of systemic uncertainties and this means that we cannot be sure if the ranges of projections they produce can really be considered the 'true' range of uncertainty. For example, the range of sea level rise projections of the Fourth Assessment Report of the IPCC were known to systematically underestimate sea level rise because none of the models represented dynamic changes in ice sheets (Solomon et al, 2007); and
- **Internal variability:** uncertainty that stems from the chaotic nature of weather and climate. This is an aleatory uncertainty, which means that it is irreducible but can be quantified.

See Fig.II.4 for an estimate of how much each of these uncertainties contributes to total uncertainty in global average temperatures and how this changes over time.

Sources: Stainforth et al. (2007)

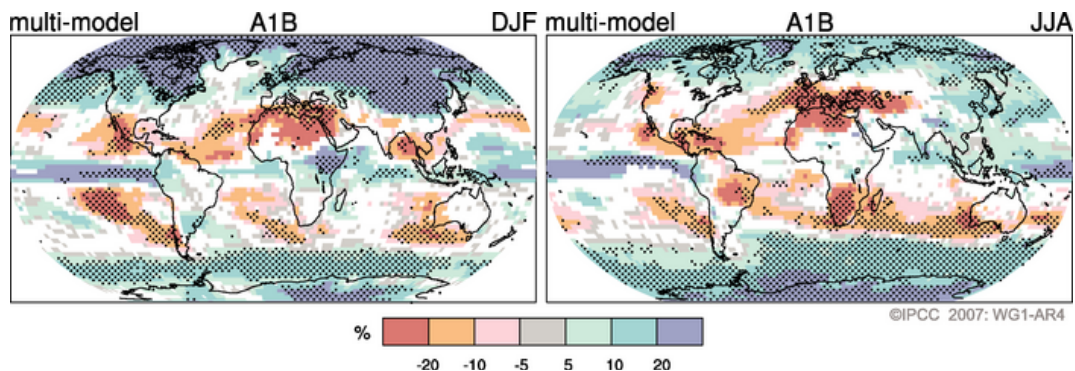


Figure II.2: Projected changes in rainfall (in per cent) for 2090-2099 relative to 1980-1999, for December to February (left) and June to August (right). The values shown are averages across a suite of models for a central emissions scenario (SRES A1B). The white areas are where fewer than two-thirds of models agree on the sign of the change. Stippled areas are where more than 90% of models agree on the sign of the change.

¹⁰ Climate models are much simpler than weather forecasting models in some ways, and more complex in others. For example, they have a much lower resolution to allow them to simulate climate over much longer time periods (centuries rather than days), but they include many more physical processes, such as ocean circulation and biological systems.

¹¹ Computing constraints, which means that we are limited in the resolution of our models and the breadth of processes that can be represented (*structural* model uncertainty). This also means that we have to make simplifications, for example in the way that we represent clouds (*parametric* uncertainty).

There are a number of additional steps that one must take to understand how this physical climate change translates into impacts on people and livelihoods at the local level – this is illustrated in Fig. II.3. The uncertainty in future climate cascades down through this chain and at each step more uncertainty is incorporated (Fig. II.3). Few of these uncertainties can be meaningfully quantified. This situation is often referred to as ‘deep uncertainty’ (Box II.2).

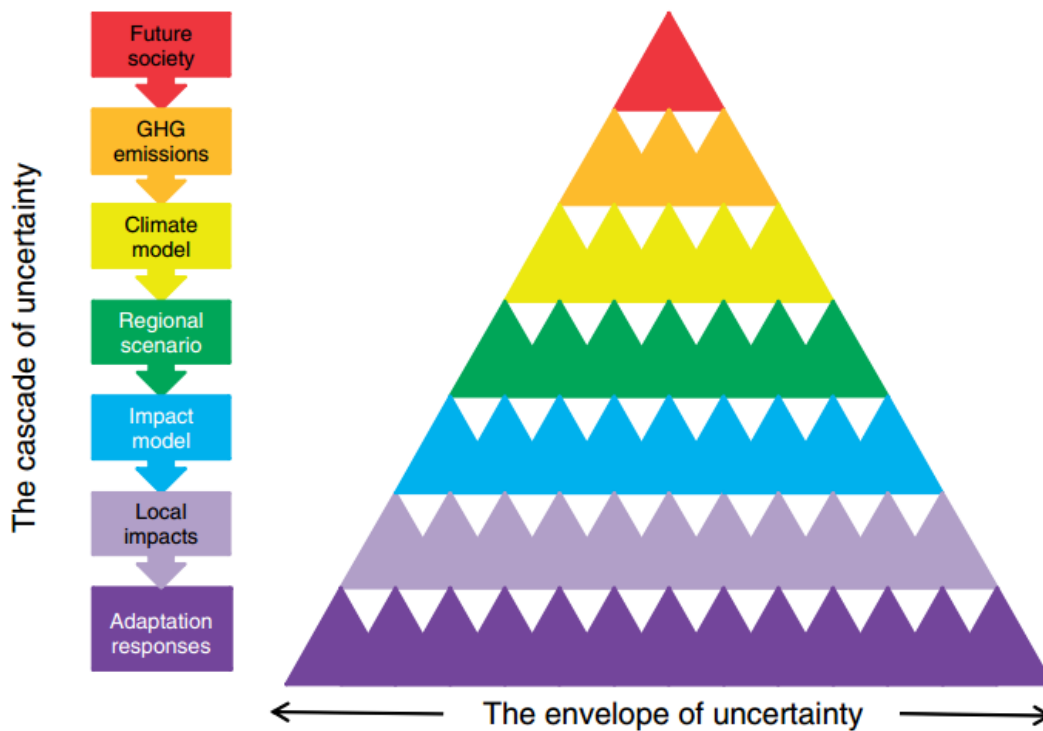



Figure II.3: The ‘cascade of uncertainty’ along the prediction chain from future societal conditions to projections of local impacts and adaptation responses. Source: Wilby and Dessai (2010).

In most cases, the largest source of uncertainty will not be changes in physical systems but in how these interact with social, ecological, economic, institutional and political systems and factors at the local scale. The vulnerability and resilience to climate (described in Fig. I.2) is itself uncertain and is changing considerably over time as a result of development progress, *autonomous adaptation*¹², changing social, economic and political circumstances, but also shocks and other pressures. These relationships are complex, rapidly changing and almost impossible to predict ahead of time. For example, the profile of vulnerability to climate in Africa is likely to change radically over the next few decades as the population continues to grow, more people move into urban areas, wealth (for most people) increases and new technologies, like new agricultural techniques, are adopted.

This final aspect of uncertainty, while arguably at least on a par with the influence of physical climate change in terms of scale¹³, is the least well studied and so is often neglected. However, it can have a considerable bearing on how adaptation strategies are designed today. For example, a recent OECD study estimated that two-thirds of the increase in

¹² Many communities have a high ability to adapt to changing climate conditions, though barriers are present and limits will be reached at higher levels of warming (Thornton et al. 2011).

¹³ Studies have demonstrated that socioeconomic change is often on a par with the influence of climate change in driving risk, and will be particularly so over the coming 30 years (Warren et al. 2006).



population exposed to coastal storm surges in the world's largest cities by the 2070s would be due to urbanisation and population growth and only one-third due to climate change (Hansen et al. 2011). Ignoring socioeconomic change would mean that adaptation plans would neglect to see the enormous benefits of urban development planning.

Some of these uncertainties will be reducible over time as more is learnt about the science of climate change and local vulnerabilities and resilience (Box [II.1](#)). But it is unlikely that they will be substantially reduced within the next 10 years or so. In some cases, we cannot wait for better information (high costs of delaying adaptation, Fig. [II.3](#)). This means that we need to learn how to make decisions under deep uncertainty about the future climate today.

Box II.2: Risk versus uncertainty – the challenge for decision making

Uncertainty itself is not necessarily a problem. Decisions are made under uncertainty every day. For example, engineers routinely make decisions about the design of infrastructure, like reservoirs, roads and flood defences, to cope with local weather conditions, which by their nature are chaotic and uncertain. In this type of situation, the planner or engineer will typically have a probability distribution, based on historical observations of the climate, and will optimise the design of a project using standard tools, like cost–benefit analyses. In economics, this situation is sometimes known as decision making under risk – that is, where the uncertainty is quantifiable.

However, the uncertainty in climate impacts is different. In making adaptation decisions, a decision maker can no longer rely on historical observations, but is forced to use model-based climate and impact projections, which inherently come with unquantifiable uncertainties (Box [II.1](#)). In this situation, traditional cost–benefit analyses can break down (see Section [IV](#)). This type of uncertainty is known as Knightian uncertainty, ambiguity or deep uncertainty.

Deep uncertainty is common across many long-term forecasts, including exchange rates, population growth, commodity prices and economic growth. Arguably, the problem is worsened in this case because of the large scale of the potential impacts.

Continued research to better constrain projections is important. However, it is highly unlikely that further research will significantly reduce uncertainties in future climate risk for the timescales in which many adaptation decisions need to be made.

II.2. Where is the uncertainty important in decisions?

We have seen that there are large and unquantifiable uncertainties in our understanding of the future impacts of climate change on people and societies. The important question is: does this really matter for the development and adaptation decisions that we make today? We argue that in many cases it will not matter. There are three reasons for this.

1. **Many of the development and adaptation decisions that we make today are not sensitive to future climate.** For example, building institutional capacity, promoting more resilient agricultural techniques and investing in early warning systems can have positive outcomes regardless of how the climate changes;
2. **Many decisions we make today are short-lived or can be adjusted over time,** so are not dependent on long-term climate change. For example, crop varieties and planting times can be changed every year; and
3. **Short- to medium-term climate is not as uncertain as long-term climate and can be more easily quantified.** This uncertainty due to climate change on these timescales will usually be small compared with normal weather variability or other factors in development decisions, like political conditions or exchange rates. Short- to medium-term climate variability will mainly be driven by natural weather processes and climate variability, which have uncertainties that are easier to quantify based on historical information (Fig. [II.4](#)).



Even where decisions are sensitive to assumptions about future climate, like long-lived infrastructure, there are many well-known approaches for reducing the risks in decision making, for example, by building in safety margins or designing infrastructure that can be adjusted over time to accommodate climatic changes. Such strategies are discussed in detail in Section III.

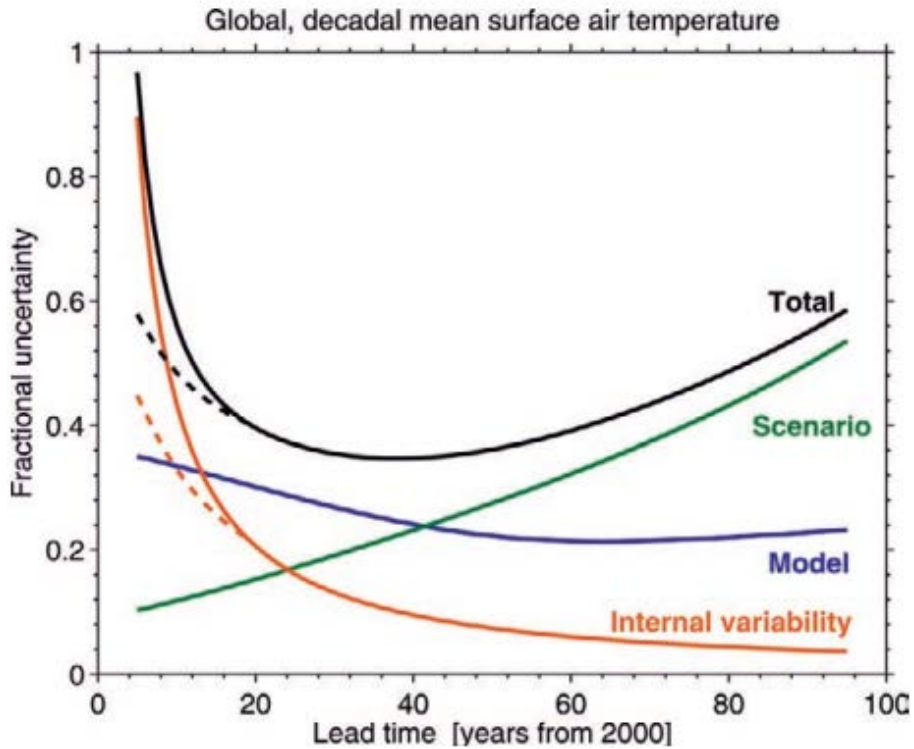


Figure II.4: Estimates of the relative importance of different sources of uncertainty in a climate model projection of global temperature¹⁴. The ‘internal variability’ is natural weather and climate variability (‘aleatory uncertainty’ in Box II.1). The scenario uncertainty is the contribution from the uncertainty about how global emissions will change – these scenarios don’t tend to diverge until around 2040. The model uncertainty is the systematic uncertainty stemming from gaps in our understanding of how the climate operates or in our ability to model processes sufficiently (Box II.1).

Case studies 2 to 5, which are presented below, illustrate the implications of climate change in five regions, three in Sub-Saharan Africa (SSA), one in Asia and the other in South America. In each of these cases – which cover agriculture, water resources and flooding – the system is sensitive to climate. In each case, there is also uncertainty about future climate. Together this results in divergent views of how communities will be affected by climate over time.

But the importance of climate change in a decision is determined not only by the sensitivity of the system to climate, but also by the characteristics of the decision itself. Where an intervention is short-lived, low-cost or adjustable over time, long-term climate change is less likely to be important in development interventions today. Similarly, if an intervention has benefits for resilience irrespective of climate change, then uncertainty over long-term climate is unlikely to be important in the decision today.

¹⁴ The quantity shown is the decadal average surface air temperature. The fractional uncertainty is the 90% confidence level divided by the mean prediction. The dashed lines indicate how uncertainty in internal variability could be reduced through improved modelling techniques.

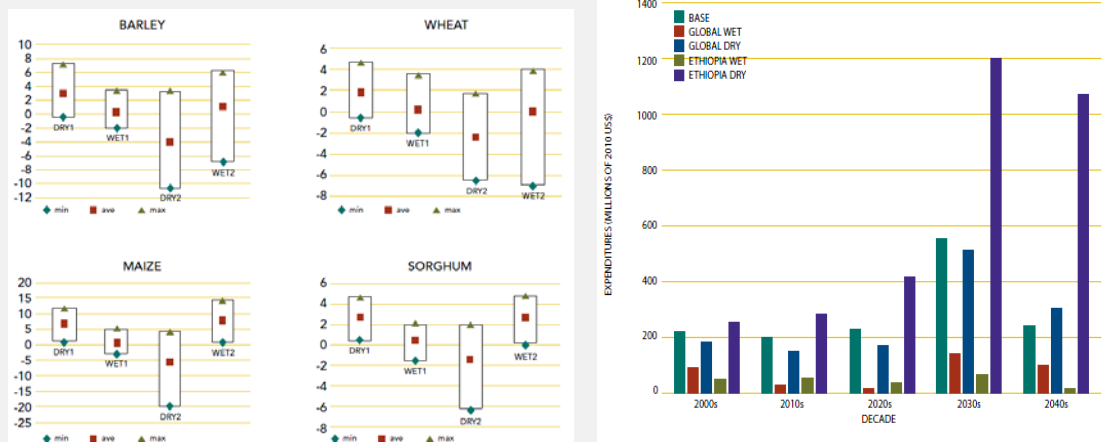


This is demonstrated in the case studies. For example, despite the uncertainty in the Maharashtra case, a range of cost-effective adaptation options are found to be available (such as drip irrigation, watershed management and insurance) which can be scaled up over time as the climate changes. These options are all relatively low-cost, short-lived and adjustable. Similarly, for agriculture in SSA (see Case Study 1 in Section I) there are many options available that have significant short-term benefits regardless of how the climate changes.

But the case studies give a glimpse at some harder choices down the line. For example, in Ethiopia, rainfall projections are starkly divergent and so decision makers would need to make a choice between investing in irrigation systems (to tackle an increasing risk of drought) or drainage systems (to tackle a rising risk of waterlogging) sometime before 2050. In this case, assuming the costs of delaying this decision are low, new information gathered over the next decade should help to pin down the right choice. A tough decision in SSA (Case Study 1) is whether and how to prepare for the chance that some communities will need to migrate if agriculture becomes unsustainable.

Case Study 2: The impacts of climate change on agriculture in Ethiopia

Agriculture contributes just under half of Ethiopia's gross domestic product (GDP). There is large uncertainty over how agricultural yields will change due to climate change, which stems partly from the divergence in climate model projections of future June–August rainfall. The impacts also vary by crop type and region. In the most damaging climate scenario, 'dry 2', yields of barley, wheat, maize and sorghum decline by, on average, between 1.5% and 5% by 2050, but year-to-year variability increases significantly more due to the rising frequency of droughts. Under the more optimistic 'wet 2' scenario, average yields rise by around the same amount, but variability continues to rise.



(Left) Ranges of projected yield variations compared with the 'no climate change' baseline and (right) Projected annual expenditure on drought relief by the Ethiopian government for four climate model scenarios and a baseline scenario.

For a dry scenario, drought expenditure increases to more than US\$1 billion per year in the 2030s and 2040s, while for a wet scenario drought expenditure remains well below US\$100 million per year. This implies starkly different allocation of resources for adaptation interventions. For example, under the driest scenario, the study proposed an investment of US\$50 million in irrigation systems before 2050; whereas for the wettest scenario an investment of around US\$37 million would need to be made in drainage systems for waterlogged areas¹⁵.

Source: World Bank (2010b), Ethiopia case study

¹⁵ Two measures were identified that were relevant in each scenario: research and development and farm and watershed management.

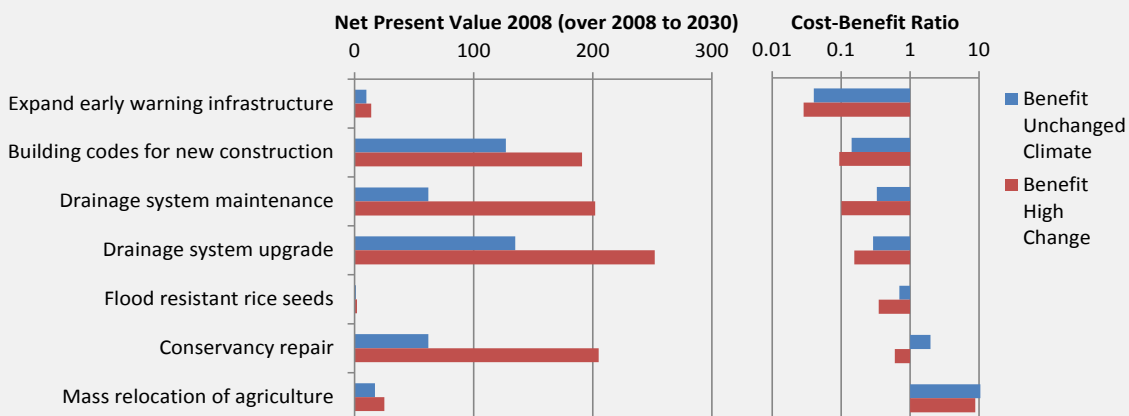
Case Study 3: Averting losses to agricultural output in Mali

Mali already experiences the highest rainfall variability in the world. Farmers in Mali cope with this using a variety of autonomous adaptation strategies, including diversified crop types. Over the coming decades, the climate could change significantly. Based on current models, average rainfall could rise by around 8% or fall by more than 10% by 2030, and temperatures could rise by between 0.9°C and 1.4°C. The result would be a fall in agricultural yields, with a loss of US\$120 million per year by 2030 in an optimistic scenario, and US\$300 million per year in a pessimistic scenario. Autonomous adaptation may avert a portion of losses – this would likely entail a migration into regions best suited for agriculture and appropriate crop types. This could be encouraged through appropriate policy and infrastructure development, but intervention would also need to address the possible adverse effects of migration, such as competition and conflict over land and resources. Despite this, it is likely that some residual loss will remain in the worst affected areas. Soil techniques, such as low tillage, and irrigation systems could help to maintain yields in these areas and are estimated to be cost-beneficial and feasible options in some parts of Mali, even in a worst-case scenario. There could also be opportunities to increase revenue through cash crops or agroforestry.

Source: Economics of Climate Adaptation Working Group (2009)

Case Study 4: Reducing the risks from flash flooding in Georgetown, Guyana

Guyana's geography makes it prone to flooding. Much of the population and agricultural production lies in a narrow strip of land along the coast, which is prone to flash flooding from rainstorms. Guyana has high levels of poverty and a lack of flood protection. 'Moderate change' climate projections are for a reduction in rainfall of around 5%, though in a worst-case scenario ('high change'), rainfall could increase by 10% by 2030. Under this scenario, expected annual losses from flooding could rise from US\$130 million (in a unchanged climate scenario) to US\$200 million by 2030 due to climate change. A wide range of measures were found to be cost-beneficial under both a moderate change and a worst-case ('high change') scenario (see Figure below), including expanding early warning infrastructure, introducing building codes for new construction and upgrading the drainage system. The only measure where climate uncertainty is shown to have a material impact on cost-efficiency is repairs to Guyana's water conservancy (flood storage) system – this is found to be cost-beneficial only under the more pessimistic ('high change') climate scenario. Subsequent analysis by the World Bank suggests that if sea level rise is accounted for, upgrades to this system become cost-effective.

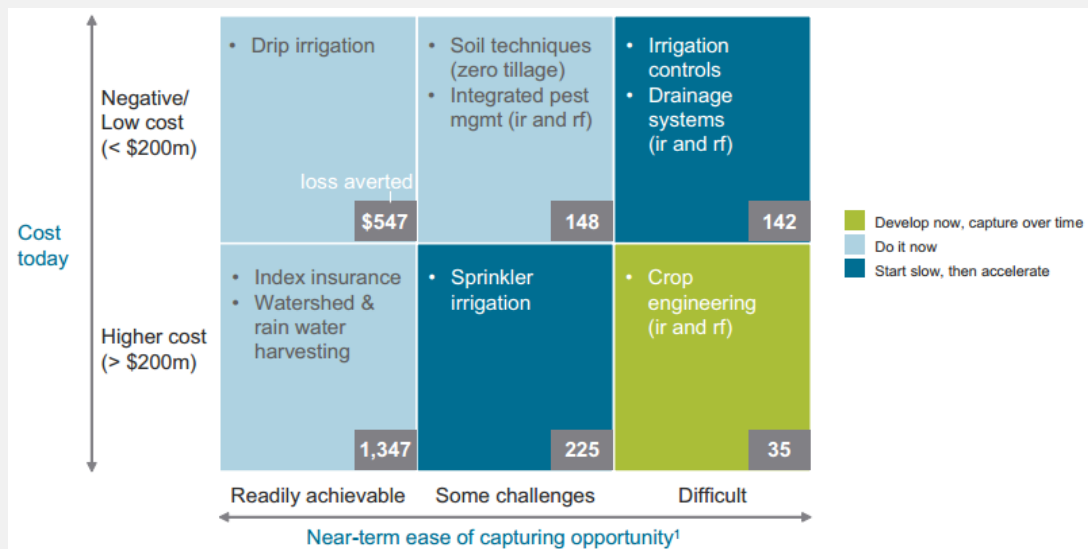


The benefit of a set of adaptation measures for flood risk management in Georgetown, Guyana, expressed in net present value (US\$ million 2008), and the cost-benefit ratio, estimated for two climate change scenarios (unchanged and a 'high change' climate scenario).

Source: Economics of Climate Adaptation Working Group (2009)

Case Study 5: Managing drought risk in Maharashtra, India

Maharashtra suffered three years of crippling droughts between 2000 and 2004, with severe impacts on the two-thirds of farmers who depend on agriculture for their livelihoods. One study showed that average climate projections indicated little change in rainfall conditions by 2030, but that in a worst-case scenario annual rainfall could decline by 8%, resulting in a several-fold increase in the frequency droughts (a one-in-10-year drought could become one in three). The study evaluated a wide range of measures for enhancing the climate resilience of agriculture in Maharashtra. They concluded that Maharashtra can avert the bulk of their expected drought losses to 2030 through measures whose economic benefits exceed or approximate their costs, including drip irrigation, drainage systems, soil techniques, watershed management, insurance and irrigation controls. These measures could be implemented incrementally over time, as illustrated below, as more is learnt about the climate.



Source: Economics of Climate Adaptation Working Group (2009)

Based on these simple concepts, Fig. 11.5 provides a general guide for screening whether a decision is likely to be sensitive to climate change and uncertainty. The first two factors relate to characteristics of the system and are the same as those given in Section I (Box 1.1). The other three factors are characteristics of the intervention itself. For a long-lived, high-cost and inflexible (non-adjustable) intervention, such as those encompassing infrastructure and buildings, uncertainty about future climate is more likely to be an important factor in the decision today. For example, a building will often last a hundred years and so will have to cope with quite radically different climate conditions over its lifetime (Hallegatte et al. 2012).

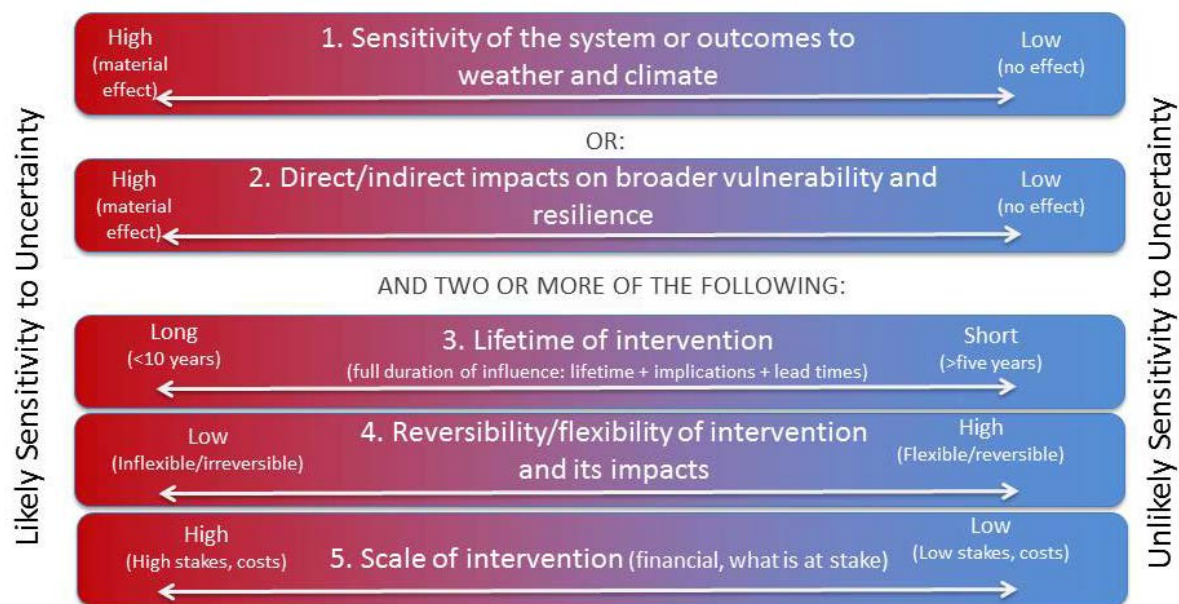


Figure II.5: Guide for identifying decisions that could be sensitive to climate uncertainty¹⁶ (based on Ranger and Garbett-Shiels [2012] and the UK Green Book Guidance [HMT/Defra 2009])

¹⁶ In using this guide it is important to remember that the full duration and influence of a programme or project will very likely be longer and deeper than the original intervention. For example, a DFID-funded project may last only three years or so, but it could influence the development prospects and climate resilience of a community or entire region for a decade or more.

Box II.3: Risk screening tools

Several organisations have developed and begun to apply climate change risk screening tools in their projects and programming. These vary in complexity. Below is one example proposed by Burton and van Aalst (2004). A more sophisticated tool, that incorporates climate change projections, is the World Bank's Assessment and Design for Adaptation to Climate Change (ADAPT) tool¹⁷. Arguably, an advantage of simple tools is their transparency and ease of use. Several summaries of risk screening tools are available, for example, the United Nations Framework Convention on Climate Change (UNFCCC) compendium¹⁸ and the upcoming review by PROVIA¹⁹. DFID has its own tool in its Climate and Environment Assessment.

A recent review by the World Bank's Independent Evaluation Group (IEG, 2012) concluded that adequate guidance is still lacking on when and how to incorporate climate risks into project design and appraisal. They suggest that current procedures are ad hoc and as a result climate risks are sometimes neglected. They recommend that the Bank develop reference guidelines for incorporating climate risk management into project and programme design, appraisal and implementation.

| Ranking | Direct risk | Effect on external risk | Effect on indirect or secondary risk |
|------------------|--|---|---|
| 1: High | Large components of the project are subject to climate risks facing a country or region (e.g. infrastructure and agricultural projects located in flood- or drought-prone areas) | The project could have a strong effect on the climate risks to which a country or region is exposed (e.g. development projects that trigger development in dangerous areas) | |
| 2: Medium | Some elements of the project are subject to direct risks, but the risk to the project as a whole is limited or only indirect | | The project may have indirect effects on the vulnerability of the country |
| 3: Low | The project is not sensitive to climate risks at all | The project does not (negatively) affect external vulnerability | |

A risk screening matrix for an intervention. OECD (2009) based on Burton and van Aalst (2004). The first column 'direct risk' maps onto the first component of the guide presented in Fig. II.5, while the second and third columns relate to the second component of Fig. II.5 (the tool also requires the user to make implicit assumptions about the other three factors in Fig. II.5).

Fig. II.6 illustrates how the guide (Fig. II.5) might be applied to screen whether an intervention is likely to be sensitive to future climate uncertainty, using a simple ranking (1 to 10). In this example, urban planning scores highly against most of the five factors – indicating that future climate is likely to be a factor in decision making. Both low-tillage agriculture and institutional capacity building score low against each of the three intervention factors (shaded in Fig. II.6), so uncertainty over future climate is unlikely to be a factor. This provides only an initial screening of the role of future climate uncertainty. The Ethiopia case illustrates that the range of uncertainty in future climate will also be a factor. Box II.3 gives a brief overview of some of the many other screening tools available.

¹⁷ http://siteresources.worldbank.org/INTCC/Miscellaneous/21315775/Poster_of_ADAPT.pdf

¹⁸ http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5457.php

¹⁹ http://www.unep.org/provia/Portals/24128/PROVIA_Draft_Guidance_on_Assessing_VIA-For_Review.pdf

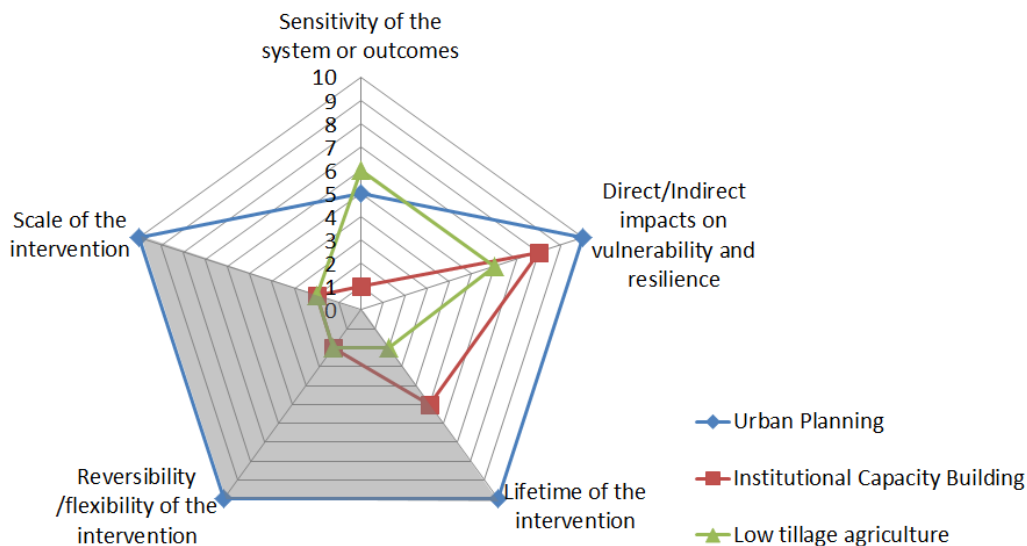


Figure II.6: Illustrative application of the rubric (Fig. II.5) to three interventions concerning urban planning, institutional capacity building and low-tillage agriculture

The interventions most likely to be dependent on climate change and uncertainty are those normally involving the public sector, such as public infrastructure, dams, coastal defences and urban and land planning decisions – these tend to have the longest lifetimes.

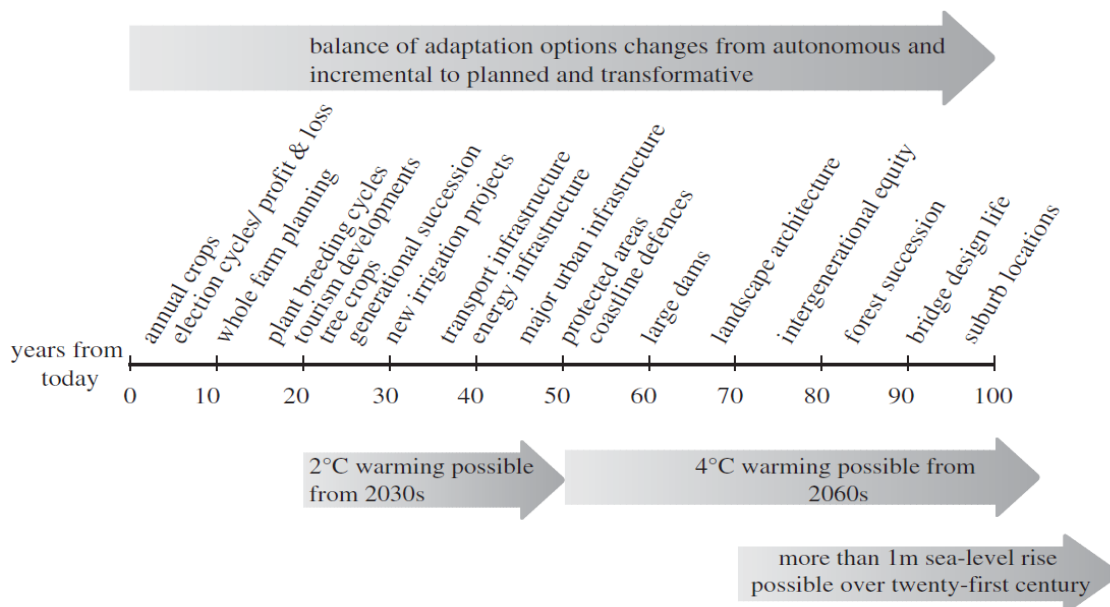


Figure II.7: The timescale of different types of intervention compared with the timescales of climate change. Source: Stafford-Smith et al. (2011)

Government policies, such as growth strategies, land use planning and sectoral planning can also be sensitive to climate change and uncertainty. These types of policies have long-lived implications and can have far-reaching and complex consequences that may inadvertently lock a society into a more vulnerable development path (i.e. the second, third, fourth and first factors in Fig. II.5).


For example, a growth policy that encourages rural-to-urban migration may have benefits for economic growth and poverty alleviation, but may result in the concentration of the urban poor in informal settlements, which tend to be more exposed and vulnerable to climate due to their location and socioeconomic circumstances. Every year 25 million people move into informal settlements in vulnerable dwellings around the world's largest cities, in many cases in hazardous areas, such as along unprotected rivers and coasts (UNISDR, 2009).

Government policy also affects social norms, sectoral development, welfare and social policy, health, education and standards for infrastructure and buildings – all of which will have long-lasting effects on vulnerability. Table II.1 gives examples of national-level decision-making processes, and specific decisions, which are likely to be affected by climate change.

Table II.1: Examples of sectoral decisions affected by climate change. Source: WRI (2011), augmented by HMT/Defra (2009) and Hallegatte (2009)

| Sector | Example of national-level decision-making process | Examples of sectoral, local or project decisions |
|--|---|---|
| Agriculture | <ul style="list-style-type: none"> National agricultural plan Crop management plan | <ul style="list-style-type: none"> Choice between irrigation and rain-fed cropping Introduction of new crop varieties Relocation of farm communities |
| Energy | <ul style="list-style-type: none"> National energy policy/strategy | <ul style="list-style-type: none"> Choice of power generation Choice to extend grid vs. distributed generation Siting of new energy infrastructure |
| Natural Resources Management | <ul style="list-style-type: none"> Coastal zone management plan Forest management plan Protected areas plan National invasive species management plan | <ul style="list-style-type: none"> Planning for endangered/protected species Establishment of protected areas Determination of maximum fish catch Choice between hard/soft coastal protection Control of disease, pests and invasive species |
| Land, Urban Planning and Infrastructure | <ul style="list-style-type: none"> National transport plan Road maintenance finance plan National highway plan Spatial (land use) planning policy | <ul style="list-style-type: none"> Urban development planning Location of mass transit Construction of bridges and highways Local of schools and hospitals |
| Water | <ul style="list-style-type: none"> National water policy Integrated water resource management plan | <ul style="list-style-type: none"> Expansion of watershed restoration Development of river basin cooperation Repair/redesign of aging infrastructure Enhancing flood control infrastructure |
| Tourism | <ul style="list-style-type: none"> National tourism plan | <ul style="list-style-type: none"> Creation of ecotourism destinations |
| Cross-Sectoral | <ul style="list-style-type: none"> Five-year national development plans National adaptation programme of action Civil contingency/emergency response planning | <ul style="list-style-type: none"> Identification of adaptation, development and disaster risk management priorities Prioritisation of sectors and populations Sectoral development/investment strategies Preparedness planning for disasters |

Fig II.5 provides only an initial screening to identify where uncertainty may be important. This can be followed up by further analysis to assess the extent of the sensitivity of outcomes to climate change and uncertainty (Sections III and IV). In some cases, planning for adaptation



to climate change reveals that systems are not adapted to current climate conditions. The Guyana [case study](#) provides an example of such *adaptation deficit* – i.e. the gap between current practice and what would be considered a well-adapted system.

The next section (Section [III](#)) will explore how interventions can be designed such that the impact of uncertainty in future climate on the outcomes is reduced.

Key messages from this section

- **Future climate and its impacts are deeply uncertain.** This means that predictions come with unquantifiable uncertainties. The level of uncertainty increases with time.
- **If climate change and its uncertainties are not well-managed from the outset of development programmes, this could mean that they fail to achieve their objectives, have a lower value for money or could create reputational damage.** Uncertainty over future climate increases the chance of taking not enough, too many or the wrong types of interventions, leading to wasted investments and higher risks for local people. This means that we need to take care to identify if and how future climate uncertainty is a factor, and to design and implement interventions in such a way as to make them [robust and resilient to the changing climate](#).
- **Uncertainty is common across all development programmes.** Development professionals deal with high levels of uncertainty every day. The difference with climate uncertainty is that it is perhaps better understood and better characterised than other types of uncertainty, over for example future political conditions or global trade, and so we have the opportunity to design more robust and resilient development programmes.
- **Uncertainty over future climate will not necessarily be a factor in many development decisions.** Uncertainty could be an important factor where an intervention is long-lived, inflexible (non-adjustable) and high-stakes (high costs and benefits). This will include, for example, interventions concerning buildings and infrastructure, urban development, sectoral growth strategies or land use planning.
- **A range of tools is available to screen the climate change risks to development projects.** A recent review by the World Bank suggested that the application of tools is still ad hoc and, as a result, climate risks are sometimes neglected in development programmes.



Where can I find more information?

Climate and impact projections:

There are several publicly available sources of climate projections online, including those specifically designed for development professionals. See, for example:

- The World Bank Climate Change Knowledge Portal:
<http://sdwebx.worldbank.org/climateportal>
- The Climate Information Explorer of the University of Cape Town:
<http://www.csag.uct.ac.za/unitar-cie/>
- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) <http://www.ccafs-climate.org/>

Sources of information on the impacts of climate change are widespread in the academic and grey literature. As a starting point, we would recommend:

- The Fourth Assessment Report of the IPCC:
http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html
- The World Bank study on the “Economics of Adaptation to Climate Change”. This report contains a series of short case studies that evaluated the risks from climate perils and adaptation options. The method was simplified – focusing on single hazards, a limited range of socioeconomic factors and short time horizons, yet the findings can be instructive. <http://climatechange.worldbank.org/content/economics-adaptation-climate-change-study-homepage>

Risk screening, or vulnerability and impact assessment:

- DFID ‘Climate and Environment – How to Note’
- ORCHID: screening development cooperation for risks and opportunities. Good introduction to the specifics of where climate change is a factor in DFID programmes. This includes a series of papers, such as a screening of DFID development cooperation in India, Bangladesh and China to identify (1) where outcomes are climate-sensitive, and (2) opportunities to enhance climate resilience. <http://www.ids.ac.uk/climatechange/orchid>
- UNFCCC Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change:
http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5457.php
- PROVIA Guidance on assessing vulnerability, impacts and adaptation (VIA).
http://www.unep.org/provia/Portals/24128/PROVIA_Draft_Guidance_on_Assessing_VIA-For_Review.pdf



SECTION III Designing policies and interventions that are robust to climate change and uncertainty

“By definition, a robust strategy is insensitive to our uncertainty about the future. It would perform reasonably well, at least compared to the alternatives, even if confronted with surprises or catastrophes”, Robert Lempert and Michael Schlesinger, 1998

“To face decision making challenges in a context of limited resources, governments can follow a strategy used by businesses in times of uncertainty – reserving the right to play in the future by establishing policies and measures that can help to keep options open”, Carolina Zambrano-Barragán, Climate Change Advisor, Ecuador²⁰

Given the uncertainty inherent in many development decisions, a *resilient* programme or project is not only one that is able to achieve its objectives today, but also one that is “*robust*, meaning that it performs well under a wide variety of futures and *adaptive* meaning that it can be adapted to changing (unforeseen) future conditions” (Walker et al. 2013). This principle is equally relevant at the national, sectoral, local and project scales.

In this section, we hope to convey that designing such programmes and projects is not necessarily complicated. We address the following issues:

1. *The three pillars of building robust and adaptive interventions: progression, flexibility and low-regrets;*
2. *Tackling climate change and uncertainty within the project cycle; and*
3. *Practical challenges of dealing with uncertainty.*


The focus on this section is on understanding what actions need to be taken today. This is the chief concern of most development professionals. In addition, when the adaptation challenge is reconceptualised in terms of its implications for near-term decisions, we find that many decisions are not so greatly affected by climate change. Indeed, well-designed interventions can actually reduce the level of uncertainty in future climate impacts, both directly, through investing in research, and indirectly, through reducing vulnerability.

Robustness and adaptability are not only relevant to addressing climate uncertainty, but can be applied to any uncertainty involved in development interventions, such as future population growth, migration, or global food prices. Importantly, robustness does not necessarily mean adapting to the worst-case scenario now – for example, building a sea wall that could cope with a worst-case sea level rise²¹. In practice, it means designing an intervention that is flexible enough to cope with or adjust to changing conditions.

There is now a very good understanding of the principles of robust and adaptive strategies (Fig. [I.6](#)) and a growing body of real case studies. However, the majority of adaptation in practice so far has focused on so-called low-regrets interventions, like climate-resilient development, capacity building or restoring mangroves in Vietnam (WRI, 2011). There are

²⁰ Quotation from WRI (2011).

²¹ This may be a suitable strategy where the incremental cost of adapting to the worst-case is very low. In many cases, adapting to the worst-case would increase the cost of the intervention.



as yet few practical cases studies where a decision maker has had to make a tough choice in the design of an intervention that is sensitive to climate uncertainty²².

III.1 Building interventions that are robust to uncertainty

Although many development professionals are aware that they are facing deep uncertainty over the future, evidence suggests that they still often develop plans based on the assumption that the future can be predicted (Walker et al. 2013, pg. 957). For example, they develop an ‘optimal’ plan based on a single ‘most likely’ future or a static ‘robust’ plan that will produce acceptable outcomes across a small number of scenarios. If the future turns out to be different to their hypothesised future, then the plan is likely to fail. This was a conclusion, for example, of the recent World Bank review (IEG, 2012).

Studies suggest that there is a **general lack of forward-looking, pro-active interventions that anticipate future risks and act to reduce them ahead of time** (IEG, 2012). The majority of development and humanitarian work on managing risks also tends to be reactive – managing events as they happen, or deliberative – learning from the recent past and adapting to it (Jones et al. 2013). This backward-looking approach brings considerable risks in a changing risk environment (Fig. [1.2](#)).

A common question is: “how do we design and implement forward-looking and pro-active interventions when there is so much uncertainty over future climate?”. Walker et al. (2013) suggests that there are broadly four ways of dealing with deep uncertainties in plans:

- *Resistance*: planning for the worst possible case;
- *Resilience*: ensuring that whatever happens in the future, the system can recover quickly;
- *Static robustness*: reducing the sensitivity of the outcomes to the widest possible range of future conditions; and
- *Dynamic robustness*: adopting plans that can change over time, in case conditions change.

Each of these approaches has its advantages and disadvantages (Walker et al. 2013). We suggest that in practice, robust and adaptive development interventions may adopt a number of these strategies, as appropriate to the situation. There are three attributes, or interlinked approaches, to designing robust and adaptive development interventions²³ (Fig. [III.1](#)), as described in detail below. They should be considered not only for adaptation interventions, but any development intervention that has outcomes that could be sensitive to climate, or influences broader vulnerability and resilience. These attributes are relevant to tackling all forms of deep uncertainty in decisions, not just climate change.

²² It is unclear if this is because climate uncertainty is ignored or if cases are unrecorded. There is a growing number of such cases in developed countries, such as the Thames Estuary 2100 project (Reeder and Ranger, 2011); or adapting water systems in southern California (Groves et al. 2008).

²³ These are based on guidance from the UK Government (HMT/Defra 2009), Ranger et al. (2010) and Fankhauser et al. (1999).

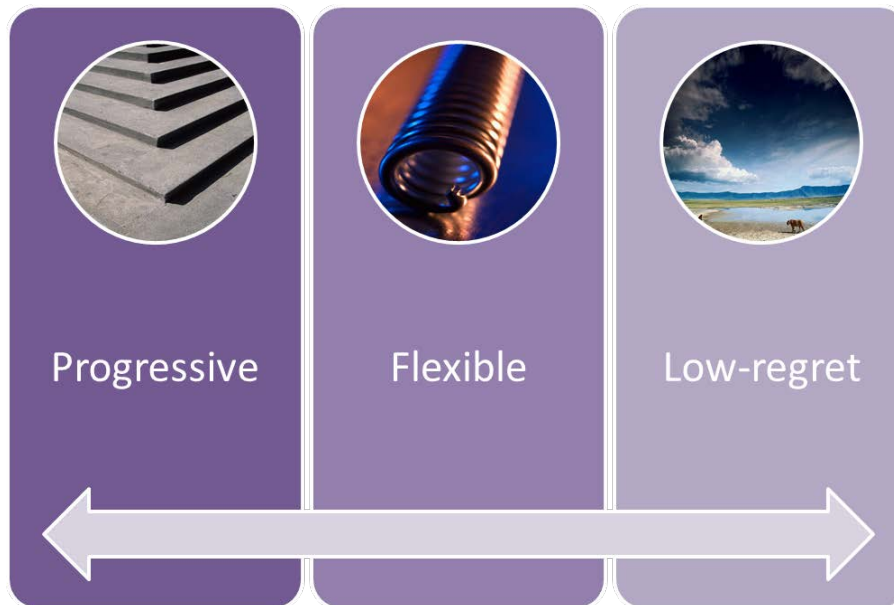


Figure III.1: Three attributes of designing robust and adaptive development interventions

Pillar 1: Progressive – forward looking, adapting incrementally over time

Adapting incrementally should be the cornerstone of the majority of interventions that have a strong climate-sensitive component. In practice, the deep and multiple uncertainties involved mean that development programmes should be a continuous, forward-looking process of planning, implementation, learning and adjustment (Willows and Connell, 2003).

Integral to this process is monitoring and evaluation. As time progresses, more will be learned about the effectiveness of different adaptation measures, the key tipping points in vulnerability and the future climate. This information must be fed back in to the decision process to adjust or refine the strategy, to enhance its performance and reduce the chance of adverse effects. The outcome of this approach should be the progressive reduction in risks associated with climate, while avoiding foreclosing options to ramp up or adjust action if necessary. Case Study 6 gives an example of incremental adaptation in managing coastal flood risk²⁴.

An important question is *how can such a long-term process of incremental adaptation fit within the relatively short project lifetime of most development interventions?* One approach would be to see the role of development professionals as providing assistance in developing the structures, capacities and resources to implement the long-term process. This could include for example: technical assistance in designing the adaptation pathway and management process; finance for initial adaptation measures; supporting the development of appropriate monitoring systems; and building human and institutional capacities to implement the plans.

Pillar 2: Building flexibility into interventions – keeping options open

Where there is uncertainty, programmes should avoid implementing inflexible measures – those that are suitable only over a narrow range of climate conditions and are costly and difficult to adjust. For traditionally inflexible measures, like infrastructure and urban planning, the solution is to design these measures in a way that builds in flexibility from the start through, for example:

²⁴ See also the Maharashtra, India, [case study](#) on drought risk to agriculture developed by the Economics of Climate Adaptation Working Group (2009), and the case studies of World Bank (2010b), which each consider the timing of adaptation options;

- *Building in safety margins*: for example, adding 30cm to the height of a bridge at the outset is relatively low-cost, but enables it to cope with a wider range of possible changes in river flow. Safety margins are appropriate where the additional costs are low.
- *Making it adjustable*: employ measures that can be adjusted or scaled up over time to cope with a climate that is more or less severe than anticipated. For example, building a reservoir so that its capacity can be increased inexpensively if needed, or a flood defence so that it can be raised. The current Thames Barrier that protects London can be over-rotated to cope with higher-than-expected extreme water levels;
- *Obsolescence*: employ less expensive measures or measures with shorter lifetimes that can be easily replaced or abandoned if necessary (for example, temporary structures); and
- *Creating future options*: invest in low-cost measures that will increase the range of adaptation options in the future. For example, supporting agricultural research to develop new types of crops, or buying land that may be needed in the future to build a reservoir.

The objectives of building in flexibility are to prevent costly over-adaptation today, while also avoiding foreclosing options that may be needed in the future (see Case Study [6](#) that follows).

Pillar 3: Incorporating low-regrets measures

Low-regrets measures have relatively low costs relative to their benefits (and co-benefits) both today and under a wide range of possible future climates – this means that their outcomes are relatively *insensitive* to climate uncertainties. A wide range of measures could meet this criterion:

- *Measures with short lifetimes and reactive measures*: for example, emergency response, changing crop varieties in response to natural year-to-year variability in weather;
- *Reducing vulnerability to current weather and climate variability*: for example, implementing social safety nets and insurance initiatives, and investing in early warning systems and improved weather prediction;
- *Reducing other stresses and risks that will increase vulnerability to climate*: for example, avoiding building on flood plains, reducing leakage from water systems and reducing practices that cause environmental degradation and soil erosion, such as deforestation and over-intensive agriculture. This may also include better managing other risks, like pests and diseases to crops, and reducing risks from malaria and water-borne diseases;
- *Adopting measures with strong co-benefits*: for example, ecosystem-based flood protection through restoring mangroves or coral reefs, which both reduces flood risk and supports livelihoods and ecosystems;
- *Measures to reduce general vulnerability and increase resilience to shocks*: for example, reducing social vulnerability through, for example, better health care and education, enhanced transport and communication networks, capacity building within institutions (e.g. on the use of climate information in decision making) and protecting ecosystem services. Increasing resilience through, for example, diversifying livelihoods; and
- *Measures to remove barriers to autonomous adaptation*: for example, reforming any regulatory frameworks that may inhibit adaptation and lead to maladaptation (for example, subsidies for rain-fed agriculture in a region becoming more drought-prone) and increasing adaptive capacity through strengthening education and disseminating climate-change projections and guidance.



Even if a measure falls into one of the categories above, it is still important to consider the effects of climate change and uncertainties on the outcomes of the intervention and consider the available evidence on whether such an option really meets the criteria for a low-regrets measure. The intervention may still affect or shift long-term vulnerability to climate directly or indirectly.

In practice a mixture of all of the three approaches will be needed. For example, low-regrets measures are not always substitutes for more inflexible measures – enhancing education is not a substitute for a flood wall or improved drainage system, though it is an important component of reducing social vulnerability and building long-term capacity.

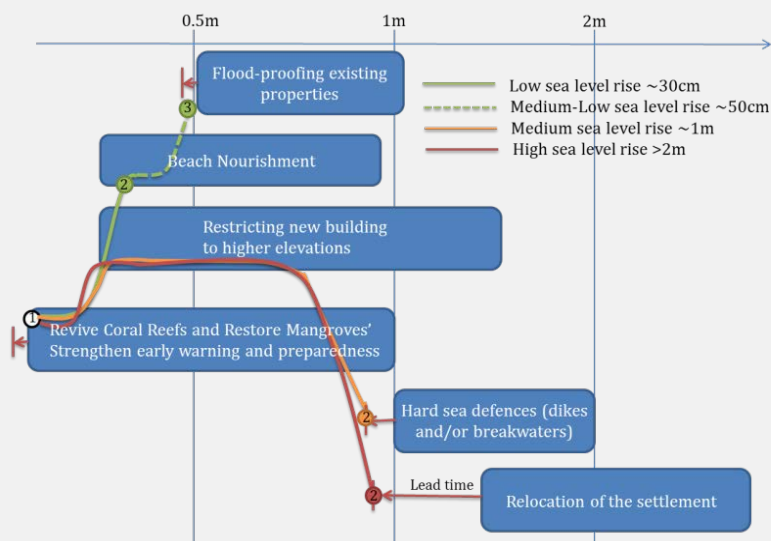
A growing number of case studies demonstrate how this simple framework can be used to construct adaptation plans that are robust to uncertainty; see, for example, a case studies for Yemen (Dessai and Wilby, 2011) and the UK (Ranger et al. 2010).

Case Study 6: Incremental adaptation to sea level rise for a low-lying settlement

The Thames Estuary 2100 project (TE2100) has become the classic example of a progressive approach to adaptation (Reeder and Ranger, 2011). The lessons gained from that case study are readily applicable to a broader range of interventions. Here, we show an illustrative example of how the ‘adaptation pathways’ approach applied in TE2100 can be used to explore the sequencing of a coastal storm surge flood management plan for a highly exposed settlement in a small-island state.

For this settlement, sea levels are expected to rise by between 30 cm and 1 m by 2100, but in a worst-case scenario, could rise by more than 2 m. Local consultations lead to the development of a number of potential options, which are effective over different ranges of sea level rise (as shown by the positions of the blue boxes below). From here, it is possible to design packages of measures that perform best for different future scenarios. For example, if sea levels were known to follow a medium-low scenario (green dashed line), then the optimal package would include reviving coral reefs and restoring mangroves; strengthening early warning and preparedness; beach nourishment; and flood-proofing new and existing properties. In the high scenario (red solid line), the best strategy would be to begin a gradual relocation of the settlement to higher land.

A challenge for the advisers is that it is difficult to switch between these ‘optimal’ packages as more is learnt without incurring significant costs. For example, while it would be easy to scale up from a low to a medium-low scenario by flood-proofing properties, moving from this to a high scenario plan would mean abandoning those properties. Similarly, taking the worst-case scenario only would not be appropriate due to its high social and cultural impact.





The adaptation pathways diagram, shown above, can help an adviser to consider ways to build in flexibility through adapting incrementally over time. The **aim is to develop an adaptation plan that reduces risk progressively, while avoiding foreclosing options prematurely or taking action that could mean wasted investments or unnecessary cost.**

The four pathways mapped out above each involve waiting and learning before making the inflexible and costly choice between flood-proofing existing properties, building hard sea defences and relocating the settlement. But there is a cost to this delay as the settlement faces a growing danger from storm surges. To reduce this risk, the plan proposes to implement a number of low-regret measures, including reviving coral reefs, restoring mangroves, and strengthening early warning systems and preparedness. But new properties continue to be built and this will lock in increasing vulnerability – to rectify this, the plan recommends a temporary restriction on development in the flood-prone area.

From this plan it will be possible to define appropriate *decision points* where the decision must be made to switch to a set pathway (decisions at these points are numbered from 1 to 3). The decision point will depend on (a) the sea level rise at which an intervention becomes effective; (b) the rate of sea level rise; and (c) the lead time of the intervention. The plan requires regular monitoring and review to reassess the pathways and decision points.

Source: author's calculation, with adaptation options taken from the Economics of Climate Adaptation Working Group (2009)

III.2 Incorporating climate change and uncertainty through the project cycle

The project cycle describes the whole process of a project, from inception and scoping to monitoring and evaluation. To tackle climate change effectively, and incorporate robustness and adaptability into the intervention, these goals must be addressed from the outset and at each stage of the project cycle.

There is now extensive guidance on approaches to address the changing and uncertain climate in the project cycle. Over the last decade, the literature has evolved significantly, as climate change moved from a science-led concern to a practical issue for planning and policymaking (Box [III.1](#)). There is now increasing agreement that climate change and uncertainty can and should be addressed using the tried-and-tested methods and tools for project appraisal and risk management, employed routinely in government and elsewhere (HMT/Defra, 2009). However, within this, we need to dust off those tools in toolbox aimed at dealing with uncertainty. Here, we review the project cycle outlined in the Green Book and highlight where climate change and uncertainty fit in, drawing on guidance including HMT/Defra (2009) and Willows and Connell (2003)²⁵ (Fig. III.2).

²⁵

See also OECD (2009) Chapter 9 and Ranger et al. (2010).

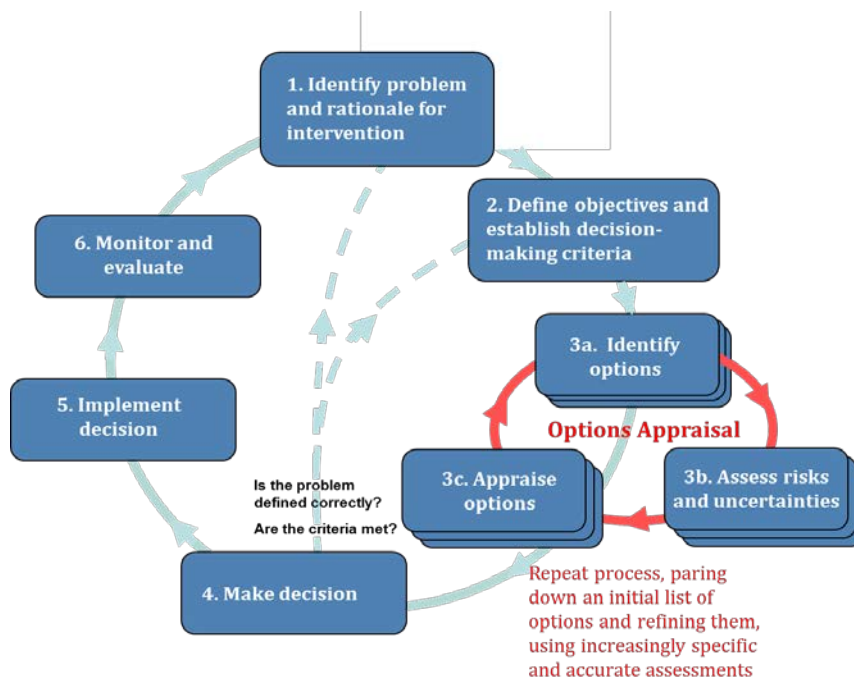


Figure III.2: The project cycle. This version is a combination of the Green Book ROAMEF²⁶ cycle (HMT, 2003) and the climate change risk management approach outlined by Willows and Connell (2003)

Setting the stage (>> *the DFID Strategic Case*)

The first stage of the project cycle is to *identify the problem and the rationale for intervention*. This stage clarifies the problem to be addressed by an intervention and outlines the justification for public action (Box III.2). It is here that the potential role of climate change should be identified and categorised, using the criteria laid out in Section 1; for example:

1. *Adaptation is a central feature of the problem to be addressed.* This is where the intervention specifically aims to reduce the impacts of climate change that the private sector or individuals would, if left to their own devices, not sufficiently either avoid or adapt to. That is, the presence of one or more ‘market failures’ justifies the public intervention, for example, raising a sea wall (a public good) or where private measures to reduce the impact of flooding in an area may far worsen the problem for others (a negative externality);
2. *Climate change could materially affect the outcomes of an intervention,* within or beyond the project lifetime (for example, an irrigation project or an agroforestry project). This will often be the case where the outcome is climate-sensitive and the intervention is long-lived and inflexible (Fig. 11.5); and
3. *The intervention could affect the climate resilience of the community or region.* This is more likely to occur if the intervention is long-lived and inflexible (Fig. 11.5). But short-lived and flexible interventions could also have long-lasting impacts on climate resilience, for example, if they altered habitual behaviours. For example, insurance schemes can lead to farmers taking less action to prevent losses, increasing long-term vulnerability (Warner et al. 2009). Guidance warns that it is important not to consider the implications of an intervention too narrowly. Any intervention that affects the social or economic vulnerability and resilience to shocks could inadvertently decrease or increase vulnerability to climate, or displace vulnerability.

²⁶ ROAMEF stands for Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback.

A decision maker should consider if a project falls into any of these categories at the start of the planning process as it could have a bearing on decisions over the objectives as well as on what resources and expertise are required to design and appraise the intervention. Some guidance recommends undertaking an initial *risk scoping* or *risk screening* exercise to help identify this (Metroeconomica, 2011). In practice, this might initially just be a ‘*what if*’ thought experiment, for example ‘*what would happen if the risks from coastal flooding increased?*’ or ‘*what would happen if rainfall patterns and drought occurrence changed?*’ and could be developed through discussion with an expert if climate is a possible factor. There are many screening tools available, each generally designed for a specific organisational or sectoral context. More in-depth tools are available (see Box [II.2](#)), but may not be necessary at this early stage in the process²⁷.

The second stage is to *define objectives and establish decision-making criteria*. Clearly defined objectives are the crucial framing for the analysis required. Until you are clear *what* is meant to be achieved and how, it will be very difficult to narrow down on possible options to achieve the objective. The objective describes the desired outcome and impact of the intervention (Fig. III.3). The *decision-making criteria* are the specific success criteria against which options will be assessed and compared. For example, they will normally include ‘*effectiveness in meeting the objectives*’, ‘*feasibility*’, ‘*value for money*’ or ‘*efficiency*’²⁸. The criteria could also be related to the objectives and the attitudes to uncertainty. For example, a criterion might be that the outcomes of the intervention are robust to long-term climate change – or in other words, that the chance of maladaptation is minimised (see Section [IV](#)).



Figure III.3: The ‘results chain’ of an intervention.

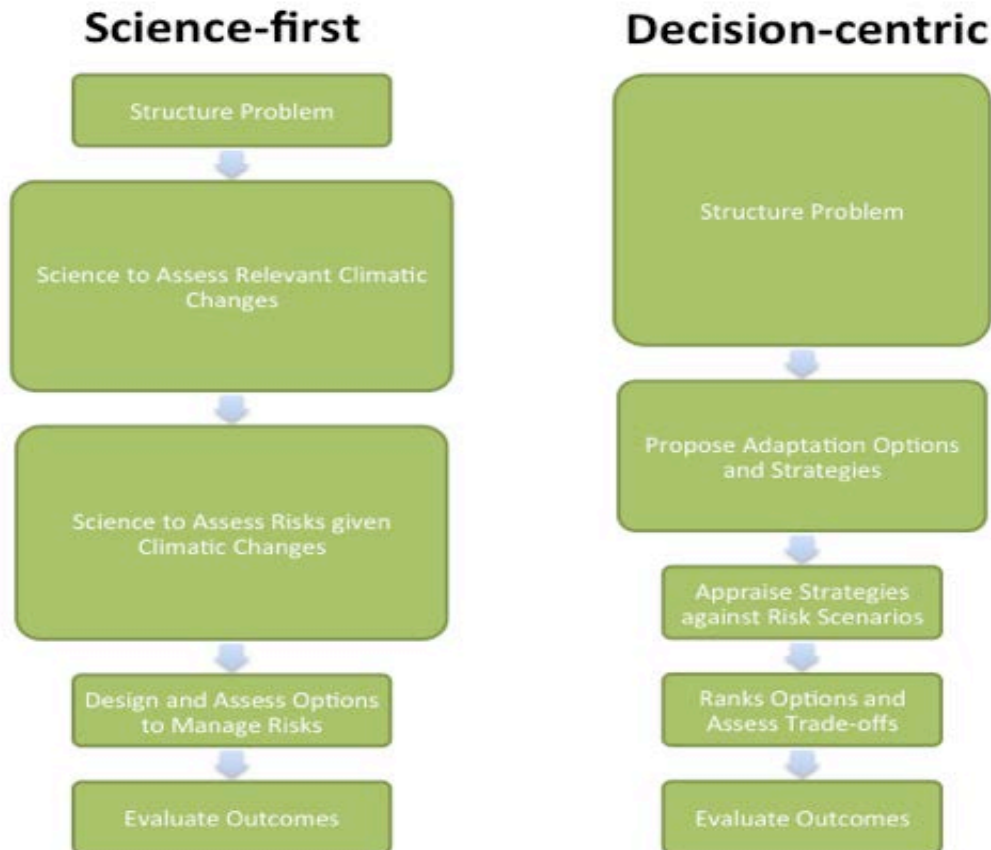
To better understand the complex and uncertain relationships between inputs and impacts, and map out decision criteria, one might employ conceptual tools like the Theory of Change and draw on consultative or participatory decision making techniques (Vogel, 2012).

²⁷ For more in-depth examples of risk assessment tools; see UNFCCC’s ‘Compendium on Methods and Tools to Evaluate Impacts of, Vulnerability and Adaptation to Climate Change’, available online.

²⁸ In appraisal, efficiency is usually defined as the expected benefits of the intervention outweighing the costs.

Box III.1: Science-first versus policy-first decision making

The decision process outlined in this section is different to the 'science-first' approach that was initially adopted by experts working on climate change related problems. A science-first process begins with the climate projections. These are used to generate impact projections. With this information, the adviser would then try to identify and assess adaptation options.



The alternative 'policy-first' approach is in line with the standard project cycle. In this approach, the focus of the analysis is on the problem itself and identifying solutions. Climate and impact projections are only involved the appraisal and refinement of different options. **Effectively, climate change is mainstreamed within the decision process, rather than being the driver of it.** This makes the approach more suitable for including climate change as one factor in a larger decision-making process, as will often be necessary in designing development interventions. A policy-first process also has the advantage of greater resource efficiency, as the scale of the climate analyses can be better tailored to meet the needs of the project and is not 'overblown'. By focusing on the problem, it also becomes easier to identify options that are more robust.

Sources: Ranger et al. (2010) and Dessai and Hulme (2007)

Box III.2: The role of the public sector in adaptation

Most adaptation will be *autonomous*, undertaken by households, the private sector and civil society. One of the responsibilities of the public sector is to undertake *planned adaptation* that is not just reacting to climate stressors but proactively preparing for expected changes in events such as heat waves or flooding (for example). One of the roles of the public sector is to provide an enabling framework that encourages and supports autonomous adaptation (e.g. Cimato and Mullan, 2010). We categorise the role of the public sector into five types, which represent different state functions and grades of public intervention:

- Providing adaptation services directly, where the public sector commissions or delivers adaptation as a public good. This includes adapting public assets, services and operations;
- Enabling adaptation in areas where public policy needs to overcome private barriers to adaptation, including financial, moral hazard, legal, behavioural or coordination barriers, or provide incentives through price signals and regulation;
- Assisting with adaptation, for example with help to vulnerable people and other support to ensure a fair and equitable adaptation outcome;
- Informing about climate risks to overcome knowledge barriers, and providing public information (climate and other) as a way to support private adaptation; and
- Monitoring risks and progress in adaptation.

Source: Fankhauser et al. (2013)

Options Appraisal (>> the DFID appraisal case)

The third stage is *options appraisal*. Options appraisal aims to identify the 'best' set of options or measures to achieve the objective, where 'best' implies the best performance against the decision-making criteria – for example, the option with the greatest *efficiency, equity, effectiveness and robustness* in achieving the objective.

Options appraisal can be a multi-stage and circular process (Fig. III.3), where an initially wide list of possible *options*²⁹ is pared down and refined to zero in on the best solution. The first pass in identifying options (3a, in Fig. III.3) may be a high-level brainstorm of the various options and their characteristics (including their benefits, risks, uncertainties and flexibility). In the first pass, these might then be appraised based on a simple qualitative risk screening and sensitivity analysis considering climate change and other long-term factors.

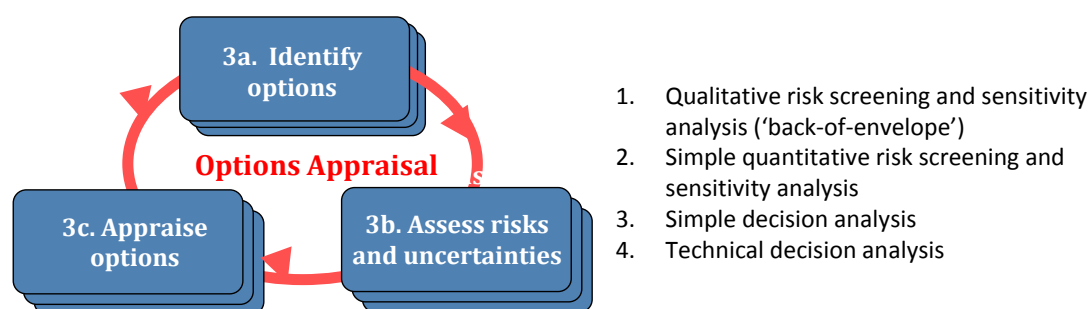



Figure III.4: Illustration of the multi-stage options appraisal, where the analysis is repeated in increasing detail until the best solution is identified.

In each cycle of the options appraisal, the analysis can become deeper, more specific and accurate, drawing in more information, until the best solution is identified. Each stage will result in a more refined list of options, which considers the timing of adaptation (Box III.3) and the opportunities to build in flexibility, low-regrets and progressive strategies as outlined

²⁹

An option may include the specific inputs, processes and outputs required to achieve a desired outcome. Guidance is available on scoping options for adaptation; for example, see UKCIP (2009) and OECD (2009) section 9.3.2(ii).



in Section [III.1](#). This process may involve stakeholder engagement (e.g. participatory decision making) to identify, appraise and refine the options. Potential risk screening tools are discussed in Box [II.3](#). The more quantitative tools for options appraisal and their inputs are discussed in Section [IV](#).

This circular process aims to ensure that the appraisal is not unnecessarily resource intense. There is no need to delve into detailed climate model projections at the start of the options appraisal – this effort would be wasted if climate change is revealed to be a small factor compared with other risks and uncertainties. Initially, some high-level climate projections (e.g. from the IPCC Assessment Reports) and a broad understanding of the sensitivity of the intervention or outcomes to climate will usually be enough to determine the importance of climate change relative to other risks and uncertainties (Ranger et al. 2010). Detailed model projections will only be needed if the design or choice between options is shown to be sensitive to climate change and uncertainty (Section [IV](#)).

The Green Book provides clear guidance on how risks and uncertainties should be considered in this process. Risks (Box [II.2](#)) should be quantified (and minimised where feasible) and their impact accounted for using the standard techniques within the economic appraisal of options (Section [IV](#)). However, as described in the previous section, climate uncertainty is deep uncertainty – it cannot be quantified meaningfully and so is not a ‘risk’. For *deep uncertainties*, like climate change (and many other long-term changes, like population growth and long-term exchange rates) the Green Book recognises that a different approach is needed. It recommends the following steps:

1. *Consider how exposed each option or strategy (a group of options) is to the future uncertainty.* For example, are the outcomes of some options more affected by uncertainty over climate change than others?
2. *Consider if and how uncertainties would affect the choice between options or strategies.* Under different climate scenarios, would option B be preferable to option A and vice versa? How much would the climate need to change to make A the preferable option? (‘Switching value’);
3. *Are there ways of designing or implementing options or strategies to reduce the impact of uncertainty?* If uncertainty is shown to be a key factor in the options appraisal, then it may be beneficial to design an option or strategy that is more robust to uncertainty, using one or a combination of the approaches given in Section [III.1](#). Timing of adaptation will be an important consideration here (Box [III.3](#)). Such options should then be appraised.

Section IV discusses qualitative and quantitative methods and tools, like cost–benefit analysis, multi-criteria analysis, robustness analyses and real options analyses that can be used to appraise options as part of this process, including, for example, the costs of delay and value of flexibility.



Box III.3: The timing of adaptation

The options appraisal should consider the timing of adaptation – *should we act now, or delay until we have more information and the uncertainties are lower?* In some cases, there good, economically rational reasons to act now to implement adaptation, but in other cases, delay (specifically, waiting and learning) may be the best course of action.

Costs of delay

The economics (discounting and learning, Section IV) would tend to favour delaying action, unless there is a cost of delay. The following are examples of situations where there is a cost of delay, strengthening the justification for early action (OECD, 2009; Ranger et al. 2010):

- *Where there are sizeable benefits (or co-benefits) to action today*, for example, climate-resilient development or reducing the risks from current climate variability;
- *Where a lack of action today could lock in long-term risks*, which are costly, difficult or impossible to rectify later. This includes adaptations to long-lived infrastructure and long-term development planning;
- *Where early adaptation could lock in lasting benefits or avoid irreversible impacts*, for example, preventing damages to ecosystems and extinction of species; and
- *Where the lead times of action are long*, such as research and development.

Benefits of delay

Where dealing with uncertainty, delay could be a useful strategy where the costs of delay are low and where there is a good chance that uncertainties can be narrowed over time; for example, uncertainties concerning tipping points in vulnerability³⁰.

Uncertainty alone is not a justification for delay or inaction; indeed, it may drive earlier precautionary action in some cases. If the decision is taken to delay, this should be the result of a deliberate decision rather than a failure to act.

Narrowing uncertainties requires experimentation, research and monitoring (Hallegatte et al. 2012). It may also be possible to reduce risks in the interim through adopting low-regrets measures, like sustainable farming practices or early warning systems³¹.


Following the options appraisal, the decision-making criteria and judgement are used to select the best option(s). This is not necessarily the end of the design process. It may be necessary to go back and reconsider the objectives and decision-making criteria in light of the findings, and then search for other options. It will also be necessary to consider appropriate processes for implementations, for example the role of the private sector or the best delivery channels. The outcome of this process should be to identify a *solution* – the specific inputs, processes and outputs of the intervention that will deliver the objective and a reflection of this *solution* in the project's logical framework and list of project deliverables.

Monitoring and evaluation (>>the DFID management case)

The Green Book explains that monitoring and evaluation should aim to “*assess to what extent an intervention has been, and will continue to be, successful, in what circumstances and why*”. We argue that to cope with climate uncertainty, monitoring and evaluation must evolve from a backward-looking process to become an integral part of the management of

³⁰ Interventions should not rely on the chance that long-term uncertainties in climate change projections and climate impacts will be significantly reduced over time.

³¹ This approach was adopted in the UK Thames Estuary 2100 project, where a major decision to upgrade the Thames Barrier was delayed whilst more research and monitoring took place and in the interim, low-regrets measures were implemented to reduce flood risk around the estuary, including upgrading smaller flood defences. The costs of delay were low in this case, because the existing barrier could provide adequate protection until at least 2030, even under worst-case sea level rise scenarios. This was possible partly because the original barrier was built with some safety margins (Reeder and Ranger, 2011).



the project. Monitoring and evaluation must become a continuous, learning process, which feeds information back into the project cycle, enabling interventions to be refined to suit changing conditions. OECD (2009) suggests that monitoring and evaluation become both a ‘learning by doing’ and ‘doing by learning’ process.

Monitoring and evaluation may also need to take place over much longer time periods than in the past, as it will take a long time to observe the full benefits (or negative effects) of a climate change related intervention, particularly where the aim is to reduce long-term risk specifically (OECD, 2009)³². The UK’s Adaptation Sub-Committee overcomes this problem by monitoring not only the effects of adaptation measures (the outcomes and impacts), but also the inputs, processes and outputs of adaptation (ASC, 2011). For example, they monitor the deployment of measures (such as levels of investment in flood defences), decision-making processes, and specific outputs (such as the fraction of new properties exposed to flooding), as well as the outcome (damages from flooding). A similar approach in monitoring performance indicators³³ was adopted by the Asian Development Bank for the Hunan Flood Management Sector Project in China (ADB, 2006)³⁴.

But as well as monitoring the progress and success of the interventions themselves, the project should also monitor the changing environment of the intervention, in order to inform future action (OECD, 2009). This may include, for example, monitoring current climate variability, vulnerability and developments in knowledge of future local climate change.

There are also a number of technical changes to monitoring and evaluating adaptation in developing countries. See, for example, Brooks et al. (2013).

III.3 Prioritising interventions in sectoral, regional and national policies

At the sectoral, regional and national level, the same general principles apply for making projects climate-resilient:

- Assess risk from climate change to achieving policy objectives;
- Assess the risk of development interventions to climate vulnerability (i.e. maladaptation);
- Identify possible cost-effective sectoral and cross-sectoral interventions; and
- Prioritise and consider timing.


Potential methods for initial screening of projects and portfolios are described in Box [II.3](#).

In planning, prioritisation plays a critical role both in allocating resources across projects, but also in identifying what should be done now and what can be delayed until later. For governments, prioritisation will occur in national and sub-national budgets and medium-term expenditure planning, but also in regional, sector and local-level planning (OECD, 2009). For a development organisation, like DFID, it is a crucial component of operational planning and portfolio management. Here, we consider how to prioritise adaptation (including climate-resilient development) interventions specifically, using the approaches from Section [III.1](#).

³² This is particularly the case for measures that aim to reduce the impacts of extreme weather, which occurs rarely.

³³ OECD (2009) also recommends using a range of performance indicators (sections 8.2.4, 9.3.4).

³⁴ See OECD (2009) Table 9.2.



In practice, resource allocation at the local, sector, or country level will consider many priorities aside from climate change. Indeed, a challenge for development professionals is that climate change is often given a lower priority as a result of its perceived long-term (and uncertain) nature, versus more pressing, immediate and certain priorities, such as poverty alleviation and economic growth (OECD, 2009; see also Section [1.3](#)). This is understandable, but this Topic Guide has described three important facts that must be considered rationally in resource allocation:

1. *Reducing the risks from climate shocks will bring immediate economic and social benefits from reduced exposure/increased resilience to current weather variability, both in terms of direct monetary and social benefits of avoiding losses, injury and fatalities, but also through safeguarding investments and hard-won advances in poverty reduction, economic growth and development in the near term (as well as the long term);*
2. *Poverty reduction, development and economic growth themselves are an important ingredient in reducing the immediate and long-term risks from climate, yet policies, projects and programmes in these areas must consider climate change, or risk inadvertently locking in greater risks in the future that would be costly to reverse in the future (Box III.3); and*
3. *In some areas there are high costs to delaying adaptation, for example, if climate change is not considered in infrastructure decisions from the start, this could lead to poorer performance, costly retrofits or earlier replacement in the medium term. Also, some vulnerable communities are already at much greater risk due to climate change.*

Timing is important in adaptation – some adaptation measures come with a significant *cost of delay* (Box [III.3](#)), while for other measures, there might be an informed decision to delay to give time to gather more information. The prioritisation of a set of interventions should be determined by not only the scale (and timing) of the risk to be avoided, but also the characteristics of the interventions, in particular, the timing of the benefits and costs of delay³⁵. Uncertainty will also play a role, for example, tending to prioritise low-regrets measures in the near-term, while avoiding locking in future risk or foreclosing options.

Based on these factors, several reports have tried to identify some generic categories of measures that will take higher priority (for example, Defra [2012]³⁶ and Fankhauser et al. [2013]) and specific priority areas for national-level policies and planning in developing countries (for example, OECD [2009] and Ranger and Garbett-Shiels [2012]).

Fig. III.5 gives the simple framework of four priority measures identified by Fankhauser et al. (2013) (see also Table III.1).

³⁵ Risk and cost of delay are not independent.

³⁶ See, for example, Chapter 9 of Defra (2012); <http://ccra.hrwallingford.com/>



Figure III.5: Four priorities for investment in adaptation identified by Fankhauser et al. (2013), to deliver effective, robust and adaptive adaptation.

Three of these pillars all entail low-regrets measures, consistent with the third pillar of Fig. [III.1](#). The remaining pillar, 'act to avoid locking in future risk', relates to the first and second pillars of Fig. [III.1](#) – avoiding lock-in through flexible and progressive adaptation. Table III.1 maps the priorities identified by Fankhauser et al. (2013) onto implications for development interventions, based on OECD (2009) and Ranger and Garbett-Shiels (2012).

Table III.1: Generic classes of priority adaptation measures (Fankhauser et al. 2013), with specific applications to development interventions (based on OECD [2009] and Ranger and Garbett-Shiels [2012])

| Generic area of priority action Source: Fankhauser et al. (2013) | Application to priorities for development interventions Sources: OECD (2009) ³⁷ and Ranger and Garbett-Shiels (2012) |
|---|---|
| <ul style="list-style-type: none"> • Adaptations with early, robust benefits. Fast tracking adaptation makes sense if the proposed measures have immediate, robust benefits that would be otherwise be forgone; for example, where there is an existing vulnerability or expected near-term impacts from climate change [low-regrets, see Section III.1]. • Areas where decisions today could lock in vulnerability profiles for a long time. Fast tracking adaptation is desirable if today's decisions could commit society to a particular, more vulnerable development path that would be costly to reverse later. Several strategic decisions fall into this category, including long-term infrastructure, land use planning and managing development trends such as growing water demand. • Building adaptive capacity. • Low-regrets adaptation measures with long lead times. It makes sense to fast track low-regrets adaptations that have long lead times, such as research and development, even if the benefits will not be accrued until later. | <ul style="list-style-type: none"> • Invest in climate-resilient development. Well-designed development policies can be a no-regrets form of adaptation through reducing social and economic vulnerability. • Reduce vulnerability to current climate variability and extreme weather events. Disaster risk management (DRM) can be a low-regrets adaptation, bringing immediate benefits. • Improve the availability and quality of climate information. Including monitoring systems, future scenarios and vulnerability assessments. • Adopt measures to reduce the immediate impacts of climate change and other stresses on the most vulnerable people and systems. Some human and natural systems, including terrestrial, marine and freshwater ecosystems, can be vulnerable even to small changes in climate. Actions could include enhancing the implementation of relevant multilateral and regional environmental agreement. • Review and adjust regulations and standards to reflect climate change impacts. For example, to help to remove any barriers to adaptation or perverse incentives (overcome market failures) on firms or individuals (Box III.2) • Incorporate climate change and adaptation considerations within national development policies, including long-term visions, poverty reduction, economic growth and sustainable development strategies. Avoid making decisions today in ways that could lock in impacts or increase future vulnerability. Instead seek low-cost ways to design strategies so that they enhance long-term resilience. • Where dealing with expensive, long-term projects, such as public infrastructure or urban planning, seek options and strategies that will build in flexibility to cope with the uncertainty over future climate. This is relevant to new projects, but also upgrades and maintenance cycles. • Building the long-term capacity for climate-resilient development, including developing appropriate institutional structures, skills and knowledge at multiple levels. • Supporting the development and deployment of relevant agricultural technologies and other innovation that can reduce long-term social and economic vulnerabilities. |


³⁷ See Table 7.3 in OECD (2009) for specific challenges and actions.

Table III.2: Immediate and short-term programmes and activities outlined in the Bangladesh Climate Change Strategy and Action Plan 2009; extract from the table presented in World Bank (2010b) (Bangladesh case study, Table ES.1). The text colour categorises the activities on the categories laid out in Table III.1: early, robust benefits (green), lock-in (brown), low-regret (red), and capacity building (grey)

| Theme | Immediate | Short-Term |
|--|--|---|
| Food, security, Social protection and health | | <ul style="list-style-type: none"> Water and sanitation programme in vulnerable areas Livelihood protection in ecologically fragile areas Livelihood protection of vulnerable socioeconomic groups (including women) |
| Comprehensive disaster management | <ul style="list-style-type: none"> Improvement of flood forecasting and early warning system Improvement of cyclone and storm surge warning Awareness raising and public education towards climate resilience | <ul style="list-style-type: none"> Planning, design, and implementation of resuscitation of networks of rivers and 'khals' through dredging and de-siltation work |
| Infrastructure | <ul style="list-style-type: none"> Repair and maintenance of existing flood embankments Repair and maintenance of existing cyclone shelters | |
| Research and knowledge management | <ul style="list-style-type: none"> Establishment of a centre for research, knowledge management, and training climate change Climate change modelling at national and sub-national levels | <ul style="list-style-type: none"> Preparatory studies for adaptation against sea level rise (SLR) and its impacts |
| Capacity building and institutional strengthening | <ul style="list-style-type: none"> Revision of sectoral policies for climate resilience Mainstreaming climate change in national, sectoral and spatial development programmes Strengthening institutional capacity for climate change management Mainstreaming climate change in media | <ul style="list-style-type: none"> Strengthening human resource capacity Strengthening gender consideration in climate change management |

We are beginning to see this type of prioritisation in real adaptation plans. For example, the Bangladesh Climate Change Strategy and Action Plan 2009 identifies low-regrets measures, like comprehensive disaster management (particularly early warning systems and raising awareness), infrastructure (repair and maintenance of protective infrastructure, embankments and cyclone shelters), mainstreaming into national, sectoral and spatial development programmes, institutional capacity building and information as immediate priorities (Table 5, World Bank, 2010b). However, the IEG (2012) reports that there are few examples in the World Bank's portfolio of successful forward-looking, progressive and flexible interventions in areas of infrastructure and land use planning – that is, measures to avoid locking in long-term risks.

Prioritising interventions is important, firstly for allocating resources across specific projects and programmes, but also for identifying what should be done now, versus later. This is relevant in national and sub-national budgets, as well as in medium-term expenditure



planning (OECD, 2009). In practice, resource allocation at the local, sector or country level will consider many priorities aside from climate change. Indeed, a challenge for development professionals is that climate change is often given a lower priority as a result of its perceived long-term (and uncertain) nature, versus more pressing, immediate and certain priorities, such as poverty alleviation and economic growth (OECD, 2009). This is understandable, but this Topic Guide has described three important facts that must be considered rationally in resource allocation:

1. *Reducing climate risks will bring immediate economic and social benefits*, both in terms of direct monetary and social benefits of avoiding losses, injury and fatalities, but also through safeguarding investments and hard-won advances in poverty reduction, economic growth and development in the near term (as well as the long term);
2. *Poverty reduction, development and economic growth themselves are an important ingredient in reducing the immediate and long-term risks from climate*, yet policies, projects and programmes in these areas must consider climate change, or risk inadvertently locking in greater risks in the future that would be costly to reverse in the future (Box III.3); and
3. *In some areas there are high costs to delaying adaptation*, for example, if climate change is not considered in infrastructure decisions from the start, this could lead to poorer performance, costly retrofits or earlier replacement in the medium-term. Also, some vulnerable communities are already at much greater risk due to climate change.

As shown in the previous section, timing is important in adaptation – some adaptation measures come with a significant *cost of delay* (Section III.2, options appraisal), while for other measures, it might be better to delay to give time to gather more information. The prioritisation of a set of climate-related interventions should be determined by not only the scale (and timing) of the risk to be avoided, but also the characteristics of the interventions, in particular, the timing of the benefits and costs of delay³⁸. As described, uncertainty plays a role, for example, tending to prioritise ‘low-regrets’ measures in the near-term, while avoiding locking in future risk or foreclosing options.


III.4 Practical challenges in dealing with uncertainty

There are many practical challenges to planning and implementing adaptation, particularly in developing countries. A full discussion of these challenges is beyond the scope of this paper³⁹. Yet, it is important to recognise here that the uncertainties inherent in long-term climate impacts can exacerbate these challenges for the following reasons:

- Firstly, designing interventions that can cope well with long-term changing risks and uncertainty will require additional resources, information and technical capacities, in an environment where there are already constraints in these areas (Lal et al. 2012);
- Secondly, officials tend to be less willing to prioritise investments where the uncertainties are high and the options more disputed (O’Brien et al. 2012). In addition, Hallegatte et al. (2012) suggest that there are particular difficulties in justifying the most robust option rather than a best option in practice; experience suggests that decision makers would prefer to delay action and invest in further research that will give them the best prediction of the future, in order to select the best option; and
- Lastly, as described above, uncertainty will require a more long-term, progressive and flexible approach to decision making in core areas like development planning

³⁸ Risk and cost of delay are not independent.

³⁹ See, for example, WRI (2011) for an overview.



and disaster risk management (DRM). Yet, there is little evidence or practical case studies on how this can be delivered in practice (Lal et al. 2012). Historically, planning and policymaking are often slow to react, learn from and foresee change (WRI, 2011). For example, a survey of Sub-Saharan African countries suggested that few currently review, update and improve their DRM plans over time (World Bank, 2008).

These challenges apply equally to country officials and donor organisations, like DFID. For example, there are open questions about how to deliver long-term, progressive interventions over 20 to 30 years or so, when the average length of an intervention is around three to five years, and operational plans are revised over each five-year Spending Review period.

The World Resources Report 2010–2011⁴⁰ (WRI, 2011) outlines five elements that are necessary to significantly strengthen the ability of all governments to make effective adaptation decisions:

- *Public communication and participation*: on-going public engagement and involvement in adaptation, including participatory decision making and community-based adaptation, are central in defining adaptation needs, selecting priorities, defining acceptable levels of risk and identifying what would constitute successful adaptation. This can include games to enhance understanding (Jones et al. 2013);
- *Decision-relevant information*: governments should step up efforts to collect and distribute information to inform climate-resilient development and adaptation, but this must be user driven, accessible, regularly reviewed, cost effective, appropriate (in terms of accuracy and scope), relevant and targeted;
- *Institutional design*: appropriate coordination between national government agencies, stakeholders and other institutions, from local to international scale, is a prerequisite for successful adaptation;
- *Tools for planning and policymaking*: methods and tools (including simple guidance, risk and vulnerability screening and more specialised decision support tools) can help public officials to make difficult adaptation decisions; and
- *Resources*: including human, social, financial and ecological resources.

These elements might form an important foundation of development interventions at the national, sectoral, local and project levels. Similar conclusions have been drawn by many other studies and this is being complemented by a growing body of detailed case studies⁴¹.

⁴⁰ The WRR is a joint publication by the United Nations Development Programme, the United Nations Environment Programme, the World Bank and the World Resources Institute. These conclusions are based on extensive consultations and research with stakeholders and experts from more than 30 countries.

⁴¹ A good summary of the evidence was provided by the recent Special Report of the Intergovernmental Panel on Climate Change on 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation'. For example, see Cutter et al. (2012) and <http://cdkn.org/srex/>, where the findings of the IPCC's Special Report are summarised in a series of papers by the Climate Development Knowledge Network.



Key messages from this section

- **A resilient programme or project is not only one that is able to achieve its objectives today, but also one that is *robust*, meaning that it performs well under a wide variety of futures, and *adaptive* meaning that it can be adapted to changing (unforeseen) future conditions.** This principle is equally relevant at the national, sectoral, local and project scales.
- **There are three possible approaches to building robust and adaptable development interventions:**
 - **Progression:** In practice, the deep and multiple uncertainties involved mean that development programmes should be a continuous and forward-looking process of planning, implementation, learning and adjustment. Monitoring and evaluation is a crucial component.
 - **Flexibility:** For traditionally inflexible measures, like infrastructure and urban planning, the solution is to design these measures in a way that builds in flexibility from the start through, for example, safety margins, designing in adjustability and obsolescence.
 - **Low-regrets:** Many types of interventions have benefits for vulnerability and resilience yet are not sensitive to uncertainty over future climate.

A resilient plan will require each of these pillars. Importantly, a low-regrets measure is rarely a substitute for flexible and progressive measures and should be subject to the same scrutiny as other measures based on a careful consideration of available evidence.
- **Implementing progressive and flexible interventions may raise institutional challenges for development organisations like DFID, where project timescales are relatively short and value for money must be demonstrated quickly. In addition, monitoring and evaluation frameworks may need to evolve from a backward-looking process, to become an integral part of the management of the project.** Monitoring and evaluation must become a continuous, learning process, which feeds information back into the project cycle, enabling interventions to be refined to suit changing conditions.
- **Climate change and uncertainty can and should be addressed using the tried-and-tested methods and tools for project appraisal and risk management, employed routinely in government and elsewhere.**
- **There are many places where it makes sense to invest early in adaptation, even though the benefits will not be accrued until later. Similarly, in some cases, the most rational cause of action will be to wait until more information is available.** The timing of adaptation interventions is an important consideration and will not only be determined by the risks to be avoided and the uncertainty, but also the costs of delay (linked to the lifetime, reversibility or absence of the intervention). The most urgent measures tend to be where not acting today can commit us to greater costs and risks in the future, such as long-lived infrastructure and urban development.
- **We can draw out four priority areas for adaptation today:**
 - **Measures with early and robust benefits:** Low-regrets measures, like climate-resilient development, early warning systems and insurance.
 - **Acting to avoid locking in long-term risks:** taking action to account for changing risks in long-term decisions such as critical infrastructure, urban development, land use change or sectoral development strategies.
 - **Capacity building:** building the capacity for implementing development programmes that are resilient to the changing environment.
 - **Low-regrets measures with long lead times:** for example, investing now in long-term agricultural research programmes to increase future options.
- **There are indications that many development interventions are failing to tackle**



the tough choices in managing long-term risks. A number of recent reviews of development portfolios suggest that the majority of so called ‘adaptation’ interventions today focus on low-regrets measures and capacity building, and are failing to address the need to avoid locking in risk.

- **There are several practical challenges to communicating and acting on uncertainty on the ground.** For example, officials tend to be less willing to prioritise investments where the uncertainties are high and the options more disputed. There are also particular difficulties in justifying the most robust option rather than a best option in practice, with decision makers preferring to delay action in anticipation of better information, despite the costs of delay. Also, historically, planning and policymaking are often slow to react, learn from and foresee change.

Where can I find more information?

- *The UK Green Book (HMT, 2003)* and its Supplementary Guidance on “Accounting for the Effects of Climate Change” (HMT/Defra, 2009). The Green Book is a surprisingly accessible source of guidance on the project cycle, options appraisal and dealing with risk and uncertainty. A downside is that it gives few case studies.
- *World Resources Report 2010-2011; “Decision Making in a Changing Climate”*. An accessible account of the practical challenges of dealing with uncertainty and how these can be overcome, including case studies, participatory decision making exercises and commentaries from world experts.
<http://www.worldresourcesreport.org/wrr-2010-2011>
- *Willows and Connell (2003)*. This report was written by the UK Climate Impacts Programme, in collaboration with Defra and the Environment Agency. We recommend having a look at other adaptation tools and reports developed by UKCIP, including “Identifying Adaptation Options” and the “Adaptation Wizard”. These are focused on the UK, but include some simple tools that are relevant to all adaptation problems.

A vast range of other adaptation guidance and tools are available. See, for example, the collection provided by the Governance Social Development Humanitarian and Conflict PEAKS (GSRDC): <http://www.gsrdc.org/go/topic-guides/climate-change-adaptation/adaptation-guidance-and-tools>



SECTION IV Climate change uncertainty and economic appraisal of development interventions

“Uncertainty over the future impacts of climate change means that the ability to use and value flexibility is vital”, Supplementary Green Book Guidance, June 2009

Economic appraisal aims to help identify options that are *efficient* and provide the *best value for money* in achieving a certain goal. It is one stage of the options appraisal process (Section [III.2](#)) and is usually the step where quantitative analysis is introduced. It compares the costs of different options with their expected benefits (Fig. IV.1), usually in monetary terms. Climate change and adaptation raise a number of challenges for economic appraisal. Many of these will not be new to development professionals – for example, a lack of data and problems in valuing benefits.

In this section, we focus on the challenge of addressing climate uncertainty in economic appraisal. This section is more technical than the earlier parts of the Topic Guide. DFID is developing guidance on the economic appraisal of interventions related to climate change. This Topic Guide does not replace that guidance, but instead aims to explain the key issues and highlight, in accessible terms, some possible approaches to cope with uncertainty. The goal is not to provide a comprehensive review, but to help development professionals ask the right questions of themselves, advisers or consultants, and be able to identify the advantages and disadvantages of various methods in their own work. It covers the following issues:

1. *Why conventional tools for economic appraisal tend to break down when there is deep uncertainty about the future;*
2. *The implications of climate change for discounting costs and benefits;*
3. *The tools for economic appraisal under deep uncertainty; and*
4. *The climate information needed in options appraisal.*

As this is a relatively new area of applied economic appraisal, there is still disagreement about what tools to use in which circumstances, as well as a lack of good quantitative case studies that demonstrate what works in practice (Hallegatte et al. 2012). For this reason, it is a good idea to get expert advice from economists experienced with climate change from the start.

In the following sections we explain briefly what can be done to assess costs and benefits of adaptation projects (Section [IV.1](#)) and the extent to which development and adaptation options are sensitive to uncertain futures and what to do about this (Section [IV.2](#)). In Section [IV.3](#), we list and briefly describe a number of tools that are useful in narrowing down the choice of feasible development and climate adaptation options in the context of an uncertain future.

IV.1. Conventional economic appraisal

Conventional economic appraisal focuses on identifying the best or optimal option(s) to achieve an objective. For example, it sets out to identify the option(s) with:

- The highest *expected net present value* (in cost–benefit analysis);
- The lowest *net present cost* to achieve a given outcome (in cost-effectiveness analysis); and
- The highest total *scoring* against criteria for the least cost (in multi-criteria analysis).

Each of these *decision-making criteria* (or *decision rules*) is about *optimising* the choice of option(s) to meet an objective. The challenge is that in some cases, this optimisation will be highly sensitive to uncertainty. If this uncertainty is ignored in the appraisal, it could lead an adviser to select an option that performs less well, or leads to adverse outcomes. The three main conventional tools are discussed below⁴².

Cost–benefit analysis

The most common tool used in economic appraisal is cost-benefit analysis (CBA). CBA compares the monetised (*discounted*) costs and benefits (Fig. IV.1) of a proposal or range of options. An adviser may wish to select the ‘optimal’ option, with the greatest benefits compared to costs (the highest *net present value*), or may simply test whether a proposal meets a criterion.

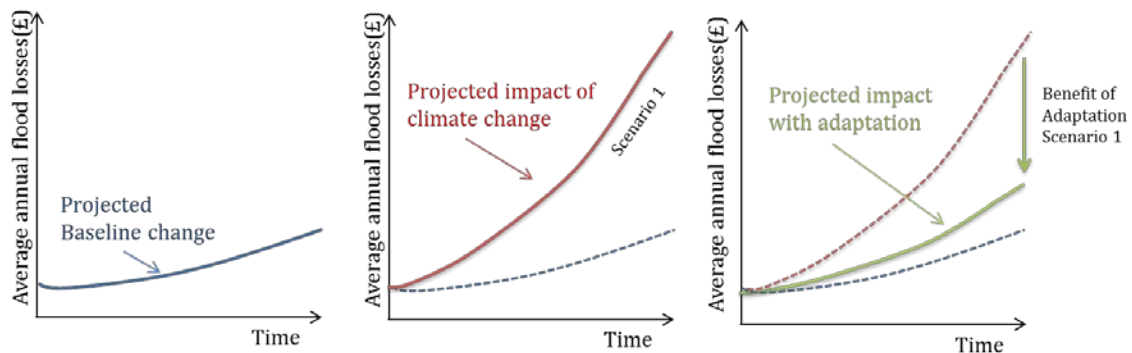


Figure IV.1: Schematic of the effect of climate change and the benefits of adaptation with no uncertainty⁴³. Source: based on Boyd and Hunt (2006)

Uncertainty can have a significant impact on the outcome of CBA. For example, Hallegatte et al. (2012) showed that the net present value of an improvement in flood protection in New Orleans could be anything from US\$0.6 billion to US\$140 billion, due to uncertainties over climate change, the valuation of non-monetary benefits and appropriate discount rates. Within CBA, quantifiable uncertainties (or *risks*) are routinely incorporated within the process by calculating the ‘*expected*’ *net present value*⁴⁴ of an option (HMT, 2003)⁴⁵. For example, weather is a risk. To account for current weather variability, a decision maker could estimate the likelihood of different levels of seasonal rainfall based on historical data. However, CBA does not provide any way for accounting for deep (unquantifiable) uncertainties, like those inherent in projections of long-term climate because of the difficulties assigning probabilities to future states (Section II). This means that where the decision is sensitive to these uncertainties, conventional CBA breaks down⁴⁶. This is true for long-term forecasts of population growth, economic growth or commodity prices.

Why can't we just fit a probability distribution to projections, or assume that all scenarios are equally likely? This might be a helpful first step, to better understand the implications of


⁴² See Pearce et al. (2006) for more specialised tools.

⁴³ A key feature of appraising adaptation options that is implicit in this diagram is that, in most CBAs, we assume that the baseline for the ‘without project’ case or do-nothing option is just a continuation of the past. With adaptation projects we need to be clear that the baseline itself is a change from the past. This will be covered in more detail in the Climate Economic appraisal guidance.

⁴⁴ Expected value is the sum of all the possible outcomes multiplied by their likelihood of occurring (HMT, 2003). This is sometimes called the ‘risk-adjusted value’.

⁴⁵ This approach is otherwise known as *expected value analysis*.

⁴⁶ Note that this is also the case for CBA’s relatives, such as *expected utility analysis*.



uncertainty, but it should not be the end game. As explained in Box [II.2](#), the nature of the uncertainties in future climate and impacts mean that estimates of the likelihood of different future scenarios, even where based on the best expert advice or best models, are not reliable and do not lend themselves to reliable probability distributions⁴⁷. Experts have demonstrated that where there is ambiguity over the likelihood of different scenarios (for example, where different experts or models would give different estimates of likelihood) it is not rational to ignore this ambiguity and rely on a single estimate⁴⁸. Such an approach could itself lead to costly maladaptation.

Box IV.1: Discounting in adaptation

Discounting adjusts for the timing of costs and benefits. In standard discounting, costs and benefits that are accrued in the future are given a lower value (known as the present value) than those that are accrued earlier, to reflect the fact that people prefer to receive goods and services now than later and the fact that we expect to be richer in the future. The UK Treasury's Green Book requires that for overseas development programmes the discount rate used be appropriate to the benefiting country. A fixed discount rate of 10% a year has often been used for a range of countries. This means, for example, that the present value of a benefit accrued in 30 years' time would have only 6% of the value of the same benefit today. The result is that the benefits tomorrow would need to be larger to justify an investment today.

Valuing the costs of delaying action

Discounting can have a big effect on the economics of adaptation, where significant benefits may only be accrued in the distant future. All else being equal, this would tend to suggest delaying an investment in adaptation. But this will not always be the case. Earlier adaptation will be justified where there are costs associated with delay, for example, where delay closes down future options (Box [III.2](#)). For advisers, this means that care must be taken to include all the benefits (and co-benefits) of adaptation, including the full costs of delaying action and value of flexibility, in the economic appraisal (HMT, 2003).

Discounting for long-lived adaptation measures

Uncertainty should also have an impact on how we discount future outcomes. For projects in the UK with long-term impacts or benefits (beyond 30 years), the UK Green Book recommends a declining discount rate to reflect the inherent uncertainty over the long term (and thus how much richer people will be in future). The logic behind this is that where there is uncertainty over the future rate of economic growth, the discount rate should not be constant but rather decline. For example, for investment in the UK, it recommends that the discount rate should decline from 3.5% to 3% beyond 30 years, and to 2.5% beyond 75 years. DFID – in line with other development agencies and with developing country governments – still uses a fixed discount rate. However, this is under review and advice should be sought from economists on what level and pattern of discount rate to use.

Adaptation to reduce the chance of very large (non-marginal) and irreversible losses

Economic appraisal techniques such as cost-benefit analysis (CBA) assume that the intervention being appraised will have only a localised or relatively limited (marginal) effect on an economy. If, however, the adaptation in question could avert the chance of a very large (non-marginal) and irreversible loss which would affect the country's growth prospects then the intervention would change the discount rate and so, technically, conventional CBA is not applicable. An example could be a programme to protect a major coastal city or the main port. There is no clear guidance yet on applying such approaches, so expert advice should be sought in such circumstances.

Source: HMT (2003), HMT/Defra (2009) and Dietz and Hepburn (2010)

⁴⁷ Generating probabilistic climate impact projections remains an active research topic in the academic community (indeed, the UK Climate Projections 2009 give likelihood estimates); if used, these estimates should be treated as subjective and complemented with expert judgement.

⁴⁸ For example, see Gilboa et al. (2009); Lempert et al. (2003) and Morgan (2003). In addition, Ellsberg (1961) and Slovic and Tversky (1974) demonstrate that in cases where there is ambiguity, subjective utility theory (on which CBA is based) is not a good model of actual behaviour as decision makers tend to put more weight on options that have a lower degree of ambiguity (i.e. they are ambiguity averse).



Cost effectiveness and multi-criteria analysis

Cost-effectiveness analysis (CEA) and multi-criteria analysis (MCA) are often used in the appraisal of development interventions, because they allow a decision maker to compare options where it is not possible to monetise all or some of the benefits. CEA compares the costs of alternative ways of producing similar outputs (Pearce et al. 2006). From here, the adviser can rank the options in terms of their cost effectiveness⁴⁹. MCA is similar, but it involves multiple objectives⁵⁰. Here, options are scored against different measures of effectiveness and then weighted based on expert's (or public's) preferences. These scores may also be based on expert judgement or quantitative methods. Uncertainty over future climate affects CEA and MCA in a similar way to CBA; it means that there is unquantifiable uncertainty over the effectiveness or scoring of different measures.

IV.2. A toolbox for decision making under uncertainty

The presence of uncertainty means that it is impossible to optimise the choice of option, so the *decision-making criteria* of economic appraisal will often evolve from *optimisation* towards *robustness*. For example, under uncertainty we tend to prefer options that:

- Minimise the *worst* outcome if the *worst-case scenario* prevailed (in maximin); and
- Minimise the *regret* across the widest range of scenarios (in robust decision making).

Put simply, where there is deep uncertainty, there will often be a preference for selecting options that are effective over the widest range of possible future climates. In Section [III.1](#), we introduced the strategies that could be adopted to help ensure that interventions meet this criterion. In this section, we are concerned with the tools that can be used to appraise those strategies. Many of these tools stem from scenario planning and analyses (Walker et al. 2013).

Regret is defined as the difference between the performance of a given strategy and what would have been the best performing strategy for the same future scenario (Lempert et al. 2003)

As discussed in Section [III.2](#), options appraisal should be a multi-stage process, where the analysis is repeated in increasing detail to refine the design and choice between options. We are assuming here that the identification and design of options has considered the pillars laid out in Section [III.1](#), and so we focus on the analysis of the choice between options.

We group the toolbox into three potential levels of analysis, discussed below. Level 1 contains the simplest tools, whereas level 3 involves more resource- and computationally-intensive tools. The appraiser need only progress to the level that is necessary to identify the best solution. For example, if the best solution is clear after level 1, then there is no need to progress to level 2. Level 1 tools should be usable by all development professionals, whereas level 3 tools are likely to require expert guidance. Here, we focus only those tools that have been applied in practice in relevant areas⁵¹.

⁴⁹ Cost-effectiveness ratio = E/C, where E is an indicator of effectiveness and C is the cost (Pearce et al. 2006). For example, the appraisal might compare the cost of saving 1 hectare of land for a range of options.

⁵⁰ CEA may also use multiple indicators of effectiveness (Pearce et al. 2006).

⁵¹ For a detailed discussion of a broader range of tools, see Ranger et al. (2010).



Level 1: Simple sensitivity testing and switching values

The Green Book recommends that it is essential to consider how uncertainty over the future affects the choice between options (HMT, 2003). The key questions being, *how does future climate affect whether Plan A or Plan B is the better choice in delivering my objective? Is uncertainty critical to whether or not the intervention will succeed in meeting the objective?*

As a first step, it recommends *sensitivity analyses* on the CBA (or similarly, CEA or MCA). For example, an adviser could repeat the analysis under two or more scenarios that represent the plausible range of what might occur in the future (including climate, but also other key changes)⁵². If the choice between options is shown to be sensitive to the uncertainties, then more detailed investigation will be required. It is also useful to consider ‘*switching values*’ – this asks, *by how much would the climate need to change to justify a different choice?* If the switching value is within the range of plausible future scenarios then again, more detailed investigation will be needed.

Sensitivity analyses are an important step to take before embarking on a more detailed appraisal – they are simple but can be revealing and can avoid unnecessarily complex analyses. For example, in practice, there are many examples of where climate uncertainty does not materially affect the choice between options⁵³ (see, for example, Case Study 3).

Where uncertainty is shown to be important, the next step is to consider whether impact of uncertainty can be reduced. This will involve scoping a new suite of options that are more robust to uncertainties, considering timing, flexibility and low-regrets measures (Section III.2). The new extended suite of options should then be re-appraised.

Level 2: Tools with moderate complexity

Where uncertainty has been shown to be an important factor in a decision (from the level 1 analysis), further analyses may be required to inform choices. Here, we give two examples of tools of moderate complexity that build on a simple scenario-planning approach – the robustness matrix and qualitative real options analysis.

Case Study 7 gives an illustrative example of a robustness matrix applied to a programme that aims to reduce flood risk in a forested region, as well as provide irrigation for local farmers. The matrix helps the decision maker to identify which options are most robust to uncertainty. The robustness matrix ranks the performance of different possible options against a set of future scenarios (including climate change but also socioeconomic factors). These scenarios aim to represent the most important uncertainties, and cover the range of plausible futures. The ranking could be based on expert opinion or a quantitative sensitivity analysis (as in level 1).

⁵² Giving an expected net present value for each future scenario (HMT, 2003).

⁵³ World Bank (2010b), ECAWG (2009) and Hallegatte et al. (2012) all include case studies where climate change is found not to affect the choice between adaptation options.

Case Study 7: A robustness matrix approach to decision making under uncertainty

The example takes a heavily forested region, with farmland downstream. Timber harvesting increases soil erosion and downstream flood risk. The objective of the intervention is to reduce flood risk, as well as provide irrigation for local farmers. A group of experts defines three possible interventions: (i) build dams, supplying an irrigation system and moderating downstream flood risk, and (ii) implement a forest management plan to reduce soil erosion and reduce flood risk.

The major uncertainties in the effectiveness of these interventions are climate change, changing demand for timber and government forestry policy. Four possible future scenarios are developed, mapping out the extremes of how conditions could change. The options and scenarios are mapped out in the robustness matrix. Each combination is rated in terms of the performance of the intervention under the scenario, from zero, for the lowest performance, to four, for the highest performance. This rating could, for example, be based on expert opinion, participatory decision making (e.g. ranking options through workshops) or on sensitivity analyses on the CBA, CEA or MCA (or a combination).

Table IV.1: Illustrative robustness analysis, based on Hallegatte et al. (2012). The values indicate the performance of each option under each of the four future scenarios. In italics is the level of 'regret' across each scenario.

| | 1: a larger dam with an irrigation system, and no forest management | 2: two small dams with an irrigation system and a small forest management programme | 3: one small dam, large-scale irrigation ponds, and a large forest management programme |
|--|--|--|--|
| A: central scenario | 4 | 3 (<i>1</i>) | 2 (<i>2</i>) |
| B: heavier rainfall and increased timber demand | 0 (<i>2</i>) | 1 (<i>1</i>) | 2 |
| C: lower rainfall and no change in timber demand | 2 (<i>1</i>) | 3 | 2 (<i>1</i>) |
| D: lower rainfall and afforestation due to government Reducing Emissions from Deforestation and Forest Degradation (REDD) policy | 1 (<i>2</i>) | 2 (<i>1</i>) | 3 |
| Worst performance | 0 | 1 | 2 |
| Average regret | 5 | 3 | 3 |
| Maximum regret | 2 | 1 | 2 |


Table IV.1 shows that all options perform more poorly if rainfall becomes heavier (scenario B). Option 1 performs most poorly because with the much heavier rainfall and no forest management coupled with higher timber demand, there is heavier soil erosion, leading to siltation of the dam and flooding. Option 2 performs best as the large forest management programme reduces soil erosion and flood risk. Option 1 also performs poorly under scenarios C and D as the larger dam is has too large a capacity for the smaller amount of rainfall.

If we adopted a 'maximin' approach, *minimising the worst outcome if the worst-case scenario prevailed* (in this case, scenario B) then we would exclude option 1.

We could also think about minimising *regret*. The regret of each option under each scenario is shown in italics⁵⁴. In terms of the average regret across all of the scenarios, option 1 again performs most poorly. Options 2 and 3 perform equally well. Option 2 performs slightly better than option 3 in *minimising the maximum level of regret* across all scenarios⁵⁵.

⁵⁴ For example, for scenario B, the regret of option 1 is 2, because 2 is the difference between its performance (0) and that of the best performing option (option 3, 2).

⁵⁵ Option 2 has a maximum regret of only 1. This is because option 3 performs poorly in scenario A.



Given that the performance of options 2 and 3 is close, Hallegatte et al. suggest that new options might be developed that take the most robust elements and combine these to create a more flexible set of options. For example, there could be another option to build the small dam (with expansion capacity) and implement a small forestry programme first, while maintaining the flexibility to increase action later after more information is gathered. The new options should be fed back into the matrix and the appraisal repeated. In some cases, the analysis could also be refined by gathering more information on the relative likelihood of the scenarios – the resulting analysis would be less robust, but could be justified if, for example, there was reliable information suggesting that one scenario had a much greater or lower likelihood of occurring.

This example has considered only one generic performance criterion. However, it could be repeated for multiple criteria, making it compatible with MCA (Montibeller and Franco, 2011).

Source: based on Hallegatte et al. (2012)

The problem with these types of analysis, as outlined by Montibeller and Franco (2011), is that they adopt less rigorous decision rules than CBA and MCA. They are more *exploratory tools*, enabling a decision maker to test the sensitivities in their plans and identify where robustness can be built in. They can also be useful tools to communicate with local stakeholders as well as inputs for participatory decision making – see, for example, the South East Queensland Climate Adaptation Research Initiative (Low Choy et al. 2012), which used scenario analyses to help local communities design their own adaptation strategies.

A similar exploratory tool is the *qualitative real options analysis* (HMT/Defra, 2009). This tool, also known as a *decision tree* or *adaptation pathways* approach (Reeder and Ranger, 2011), can help an adviser to map out how options can be implemented flexibly and progressively, to give the best performance over time, while maintaining the future option to adjust or scale up plans if need be.

Figure IV.2 gives an illustrative decision tree for three new options, or *pathways*, identified for Case Study 7⁵⁶. These new pathways incorporate flexibility by scaling up action during a second phase after more information is gathered (for example, scaling up forest management in pathway 1, or staggering the building of dams in pathway 3). The performance ratings show that in all but one case, performance either remains the same or improves compared with the one-off measures in Table IV.1. An adviser could refine this decision tree by considering at what point in time, or threshold in observed climate change, the decision would need to be made to select between options in the second stage (see also Section III.2 and Case Study 4).

⁵⁶ For simplicity only three scenarios and two distinct time periods are considered.

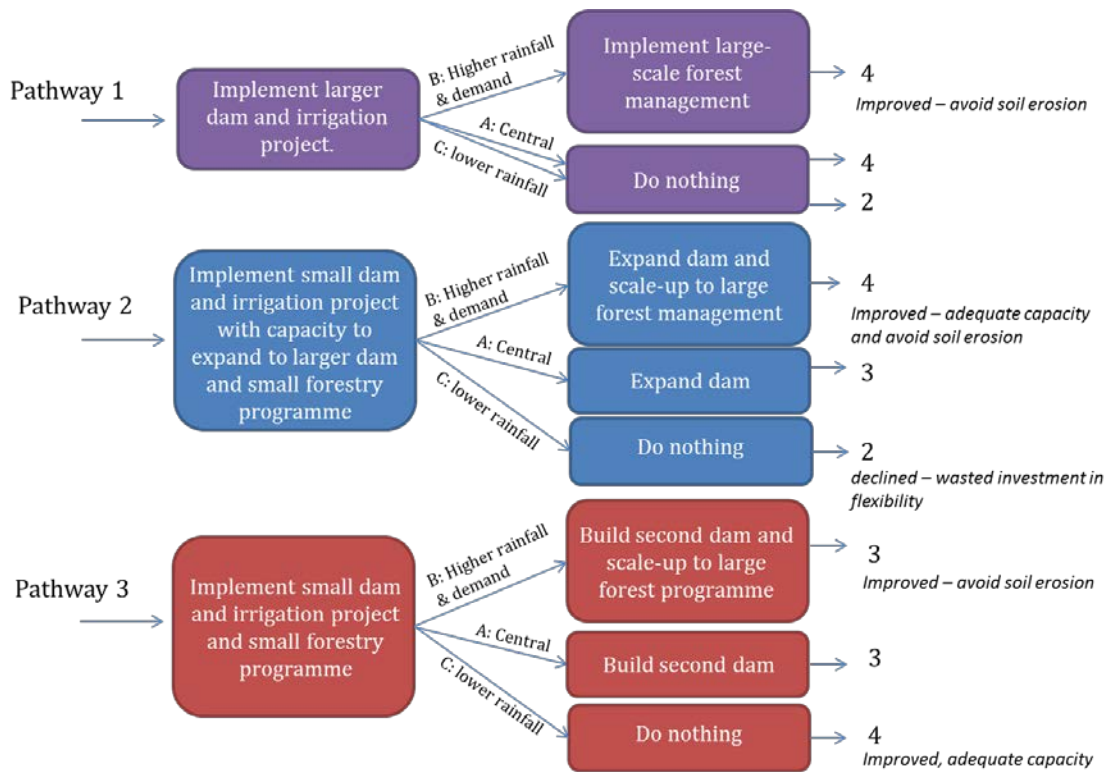


Figure IV.2: Illustrative extension to Table IV.1, using a decision tree to consider how flexibility could be built in through a multi-stage adaptation process. Source: author’s estimates based on Hallegatte et al. (2012)


Level 3: The expert toolbox

In some cases, the simple tools may lead to a very clear answer and no further analysis will be needed. But where there is a more difficult choice between options, a more formal decision method can be helpful. Below we list and discuss some formal tools being increasingly used in adaptation planning, based on Ranger et al. (2010) and Hallegatte et al. (2012). Table IV.2 compares and summarises a selection of broader decision tools.

Many tools are available to inform decision making under uncertainty. A challenge is that many have resource needs (in terms of time, skills and data) that are unrealistic, except for major projects.

Firstly, **robust decision making (RDM)** works in a similar way to the robustness matrix above, but is far more exhaustive in its testing of the interdependencies of scenarios, priorities, options and objectives. This makes it quite resource-intensive to apply⁵⁷. A major (and attractive) component of RDM is its focus on participatory decision making to identify vulnerabilities, priorities and suitable options. RDM is applied through a progressive process, where findings are presented to stakeholders and then refined based on their input to zero in on the most acceptable solution. RDM can incorporate probabilistic information, as well as missing and imprecise probabilities and differing expectations of the future, in an exploratory mode as part of the participatory process. For further information see, for example, Groves et al. (2008) and Feifel (2010).

⁵⁷ Previous applications have been very resource intensive because they have involved complex simulation models, for example of water resources management in Southern California (Groves et al. 20087).



Climate-informed decision analysis (CIDA): this is similar in principle to the robustness matrix approach above, with the key difference being the use of estimates of the ‘plausibility’ of different climate scenarios (based on expert judgement and climate modelling) to identify the ‘best’ option. This approach tries to make the best use of available climate information, recognising the deficiencies. A downside is that it is reliant on subjective judgements about the plausibility of different climate scenarios. See two case studies; Brown (2010) and Brown et al. (2011).

There have been several critiques of robustness-based approaches, like RDM and CIDA. The first is their inherent pessimism and sensitivity to the worst-case scenario, which it is argued, will increase the cost of an intervention. Hallegatte et al. (2012) respond that this is unavoidable given the nature of the uncertainties involved – ignoring uncertainties will lead to poorer performance of the intervention. We add that a robustness-based approach need not lead to higher costs; if the options scoping is thorough it should reveal more flexible options with no higher costs provided the options are considered at the highest feasible level of the logframe (outcome) rather than just choice of delivery partner (inputs).

Secondly, a further critique, particularly of RDM, is that it is more resource- and data-intensive to apply than the conventional approaches. The World Bank and others are currently working on the design and testing of more ‘resource light’ versions of RDM.

Real options analysis (ROA) is very different to RDM and CIDA. ROA is similar to CBA⁵⁸, but provides a much richer framework to incorporate timing and uncertainty into a decision, and importantly, to value flexibility – specifically the value of a ‘real’ option being available in the future, as a result of an action taken today. For example, it provides a framework for appraising the value of waiting and learning before acting, or of building a flood defence with larger foundations now, so that it can be easily upgraded in the future. If this value of flexibility of an option is not included in the appraisal, then its total value will be underestimated. The Green Book recommends that ROA is suitable for projects, programmes or policies where there is uncertainty over the future, the potential for flexibility to adjust plans and the potential to learn – that is, to make a better decision in the future through learning more (HMT, 2003). This learning might occur, for example, as a result of growing knowledge about the climate over time, through investments in modelling or through monitoring the changes that occur. The classic example of a ROA applied to adaptation is the Thames Estuary 2100 project (see Reeder and Ranger, 2011).

Aside from its ability to rigorously value flexibility, ROA is attractive because it readily fits within the conventional framework of optimising decisions. A critique of ROA for adaptation planning is that it (strictly) requires estimates of the likelihood of each future scenario. But ROA can be used in a sensitivity testing mode (as in the TE2100 case). For example, it can be used to assess how large the probability of a worst-case outcome would need to be to justify switching to plan B. Expert judgement may then be able to help determine if this threshold is realistic. Even without probabilities, ROA can be a useful tool in helping to identify key decision points in an incremental strategy (see Case Study 6 and Reeder and Ranger, 2011).

⁵⁸ It is similar in that streams of costs and benefits over time are computed for each possible adaptation pathway, under different climate change scenarios, to calculate a net present value for each path and scenario.

Table IV.2: Brief summary of decision tools. Source: Extract and update from Ranger et al. (2010)

| Decision tool | Decision-making criteria | Assumptions | Future scenarios |
|---|--|---|--|
| Methods when exact probabilities are known | | | |
| Cost-benefit analysis (expected value analysis) | Economic costs and benefits | Risk neutral. Time discounting. Does not account for equality of outcomes Only marginal costs and benefits | Requires known probabilities over all events No learning |
| Expected utility analysis | Consumption (including non-monetary factors) | Time discounting Can account for non-marginal change, risk aversion and equality of outcomes. | Requires known probabilities over all events No learning |
| Multi-criteria analysis | Multiple criteria | As for expected utility analysis | Requires probability distributions |
| Methods where exact probabilities are known, but will change over time | | | |
| Real options analysis | As for expected utility analysis | As for expected utility analysis and accounts for learning and flexibility | Requires known probabilities, as well as model of how probabilities respond to new information |
| Methods when exact probabilities are not known | | | |
| Maximin expected utility | As for expected utility analysis | As for expected utility, but pessimistic (acts as if the worst plausible probability distribution were correct) | Multiple plausible probability distributions |
| Maximin Minimax regret | Any criteria Any criteria | Ranking of outcomes Information on how much better one outcome is than another | No likelihood information No likelihood information |
| Robust decision making | Multiple criteria | Information on how much better one outcome is than another | Multiple plausible probability distributions for exploratory analysis |
| Climate-informed decision analysis | Multiple criteria | Information on how much better one outcome is than another | Subjective probability distribution |
| Info-gap decision theory | Multiple criteria | Does not rigorously account for preferences. Assumes satisficing thresholds ⁵⁹ | A 'best guess' model of the decision environment, and a set of models that are 'close' to this best guess. |

IV.3. Climate information for decision making

In this sub-section, we briefly explore the climate information needs for decision making. The type of climate and impact scenarios needed for options appraisal will vary based on the problem itself. A full discussion of the appropriate information is beyond the scope of this Topic Guide. Below we give a few general recommendations and provide links to where readers can obtain further information.

Firstly, we recommend taking a scenario-based approach, both to climate change but also for other major changes that are important to the case, such as population changes. In all cases, the **central principle must be that the scenarios cover the plausible range of possible futures across the dominant sources of uncertainty**. Indeed, Lempert et al. (2003) emphasise the value of representing the extremes of what might happen in the options


⁵⁹ A satisficing threshold is the value of a decision criterion at which an adaptation option is considered good enough.

appraisal and HMT (2003) warns against incurring spurious accuracy by using too narrow a scenario set. See, for example, Low Choy et al. (2012) for a good example of where scenarios have been developed for adaptation planning in a community in Queensland, Australia, and used to engage communities in appraising adaptation options.

Importantly, the range of projections from climate models does not represent the full range of uncertainty. This is because models tend to share similar deficiencies and so the final projections can often be biased. Scientists can advise on where this might be a problem and ways to resolve it. This might include some scenarios based on expert judgement, as was used in the Thames Estuary 2100 project to explore the uncertainties due to missing ice sheet processes in the models (see, for example, Reeder and Ranger, 2011).

Table IV.3: A review of methods to generate regional climate scenarios (Wilby et al. 2009)

| Method (application) | Advantages | Disadvantages |
|---|--|--|
| Sensitivity analysis <i>Resource management, Sectoral</i> | 1. Easy to apply; 2. Requires no future climate change information; 3. Shows most important variables/ system thresholds; 4. Allows comparison between studies. | 1. Provides no insight into the likelihood of associated impacts unless benchmarked to other scenarios; 2. Impact model uncertainty seldom reported or unknown. |
| Change factors <i>Most adaptation activities</i> | 1. Easy to apply; 2. Can handle probabilistic climate model output | 1. Perturbs only baseline mean and variance; 2. Limited availability of scenarios for 2020s. |
| Climate analogues <i>Communication, Institutional, Sectoral</i> | 1. Easy to apply; 2. Requires no future climate change information; 3. Reveals multi-sector impacts/vulnerability to past climate conditions or extreme events, such as a flood or drought episode. | 1. Assumes that the same socio-economic or environmental responses recur under similar climate conditions; 2. Requires data on confounding factors such as population growth, technological advance, conflict. |
| Trend extrapolation <i>New infrastructure (coastal)</i> | 1. Easy to apply; 2. Reflects local conditions; 3. Uses recent patterns of climate variability and change; 4. Instrumented series can be extended through environmental reconstruction; 5. Tools freely available. | 1. Typically assumes linear change; 2. Trends (sign and magnitude) are sensitive to the choice/length of record; 3. Assumes underlying climatology of a region is unchanged; 4. Needs high quality observational data for calibration; 5. Confounding factors can cause false trends. |
| Pattern-scaling <i>Institutional, Sectoral</i> | 1. Modest computational demand; 2. Allows analysis of GCM and emissions uncertainty; 3. Shows regional and transient patterns of climate change; 4. Tools freely available. | 1. Assumes climate change pattern for 2080s maps to earlier periods; 2. Assumes linear relationship with global mean temperatures; 3. Coarse spatial resolution. |
| Weather generators <i>Resource management, Retrofitting, Behavioural</i> | 1. Modest computational demand; 2. Provides daily or sub-daily meteorological variables; 3. Preserves relationships between weather variables; 4. Already in widespread use for simulating present climate; 5. Tools freely available. | 1. Needs high quality observational data for calibration and verification; 2. Assumes a constant relationship between large-scale circulation patterns and local weather; 3. Scenarios are sensitive to choice of predictors and quality of GCM output; 4. Scenarios are typically time-slice rather than transient. |
| Empirical downscaling <i>New infrastructure, Resource management, Behavioural</i> | 1. Modest computational demand; 2. Provides transient daily variables; 3. Reflects local conditions; 4. Can provide scenarios for exotic variables (e.g., urban heat island, air quality); 5. Tools freely available. | 1. Requires high quality observational data for calibration and verification; 2. Assumes a constant relationship between large-scale circulation patterns and local weather; 3. Scenarios are sensitive to choice of forcing factors and host GCM; 4. Choice of host GCM constrained by archived outputs. |
| Dynamical downscaling <i>New infrastructure, Resource management, Behavioural, Communication</i> | 1. Maps regional climate scenarios at 20-50km resolution; 2. Reflects underlying land-surface controls and feedbacks; 3. Preserves relationships between weather variables; 4. Ensemble experiments are becoming available for uncertainty analysis. | 1. Computational and technical demand high; 2. Scenarios are sensitive to choice of host GCM; 3. Requires high quality observational data for model verification; 4. Scenarios are typically time-slice rather than transient; 5. Limited availability of scenarios for 2020s. |
| Coupled AO/GCMs <i>Communication, Financial</i> | 1. Forecasts of global mean and regional temperature changes for the 2020s; 2. Reflects dominant earth system processes and feedbacks affecting global climate; 3. Ensemble experiments are becoming available for uncertainty analysis. | 1. Computational and technical demand high (supercomputing); 2. Scenarios are sensitive to initial conditions (sea surface temperatures) and external factors (such as volcanic eruptions); 3. Scenarios are sensitive to choice of host GCM; 4. Coarse spatial resolution. |



Secondly, scenarios should start off simple, and then be refined as necessary. For example, at the initial stage of an appraisal process, simple ‘what if’ scenarios may be sufficient. These can be based on historical events, climate analogues (for example, testing the resilience to events that have occurred in neighbouring regions) or publically available sources, like the IPCC Assessment Reports. However, for major projects, where the initial appraisal has shown that the choices are very sensitive to uncertainty, detailed scenarios may be required. For example, construction of a new major dam will require detailed climate and hydrological modelling.


Thirdly, seek expert advice where more detailed projections are required. As explained above, some development interventions may require detailed, high-resolution information about future climate at the local scale. Yet, there are significant uncertainties in such information, requiring expert interpretation. We recommend Wilby et al. (2009), which provides a detailed review of the methods to generate scenarios – see Table [IV.3](#) for a summary of the advantages and disadvantages of different techniques.

There are a number of issues to consider in using climate projections in detailed assessments, for example:

- *Do not confuse weather and climate, particularly in the medium term (next 20 years):* When generating scenarios, it is important not to inadvertently confuse uncertainty due to natural weather variations, with the uncertainty driven by human-made climate change. Over the next few decades, weather variations can actually be larger than the effect of climate change. This means that a climate model could produce a projection of a 30% decline in rainfall by 2020, but this could actually be just normal year-to-year weather variations. If this change is mistaken for climate change then it could lead to significant over-adaptation. Scientists can quantify and remove the effect of weather by running large *ensembles* of the same climate model, or (more simply, but less effectively) averaging over long time periods. Decision makers should seek input from experts to identify if natural weather uncertainty has been quantified adequately in scenarios; and
- *Downscaling a projection to the local scale increases its precision, but will also increase its uncertainty.* Global climate models are often downscaled to produce local projections. Downscaling enhances projections for a locale by better representing local factors that affect climate, like mountains. Downscaling is done using either a high-resolution *regional climate model* or an empirical (statistical) model, coupled to a global model. Because the downscaling still uses the global model, its uncertainty is still present in the projections. The downscaling model adds an additional layer of uncertainty. For this reason, for regional projections, it is important to capture both the uncertainty due to the global model, and that due to the downscaling model (e.g. by using multiple models).

Models should always be complemented by expert and local knowledge to ensure that their outputs are suitable and accurate for use in policy (Hallegatte et al. 2012).

Finally, in some cases it may be necessary to commission new analyses to generate appropriate scenarios. But importantly, the decision maker must consider whether the value of additional information is worth the cost. In all cases, the key is not to aim for perfect information, but sufficient information to enable a thoughtful consideration of options (OECD, 2009; Ranger et al. 2010). It could take years and significant financial resources to fully understand the vulnerability of one community, or develop a suite of regional climate model projections. Decision makers should not jump to commissioning new modelling or downscaling exercises. There are many existing studies available that are likely to provide sufficient information, particularly given the uncertainties inherent in all projections. There are particularly strong arguments over the value of expensive and time-consuming downscaling exercises using regional climate models. Hallegatte et al. (2012) comment that a skilled climatologist, with a few days’ work, can usually provide a projection that is just as good as that



which a downscaling exercise would produce in several months. Funding the skilled local climatologist has the additional advantage of building local capacity.

Broader information needs

While in this section we have focused on climate information, typically the most important input to an appraisal process will be an understanding of the **vulnerability of a system to climate shocks and losses** (Ranger et al. 2010) and the socioeconomic trends that may influence vulnerability over the long term. Historical losses from weather and vulnerability to past climate variability can be a crucial indicator of future vulnerability. However, one must also tease out the drivers of future vulnerability, including the capacity of the system to adapt autonomously (OECD, 2009).

OECD (2009) suggests the need for special attention to the sensitivity of more vulnerable groups, including women, children and marginalised groups. Tipping points in vulnerability are also important to map – for example, the level of climate change at which the impacts would become much worse, on the tolerance of a crop variety or the performance of a water system, for example. The analyses should ideally also consider international vulnerability, for example, to global food prices; however, in practice such additional analysis may not be feasible or practical.

Key messages from this section

- **The key to success in applying this section is ensuring that the options being appraised have been considered at the right level.** They should ideally be at the outcome level or, failing that, the output level.
- **The Green Book recommends that it is essential to consider how uncertainty over the future affects the choice between options,** for example *how does future climate affect whether Plan A or Plan B is the better choice? Is uncertainty critical to whether or not the intervention will succeed in meeting the objective?*
- **The conventional tools for economic appraisal, like cost–benefit analyses and cost-effectiveness analyses, break down when there is deep uncertainty.** Each of these tools *aims to optimise* the choice of option(s) to meet a certain objective. The challenge is that in some cases, this optimisation will be highly sensitive to uncertainty. These tools have no formal way of dealing with deep uncertainty. If this uncertainty is ignored, it could lead an adviser to select an option that performs less well, or leads to adverse outcomes.
- **To deal with uncertainty, a first step is to *sensitivity test* the cost-benefit analysis (or equivalent) to uncertainty, and to consider ‘switching values’.**

Where necessary, an expert toolbox of decision methods, such as robust decision making and real options analysis, is available to help in appraising options. A challenge is that these can be resource-intensive to apply in practice and they are relatively untested in development interventions.




Where can I find more information?

- DFID economic appraisal guidance for climate change (forthcoming)
- *The UK Green Book* (HMT, 2003) and its Supplementary Guidance on “Accounting for the Effects of Climate Change” (HMT/Defra, 2009). The Green Book provides guidance on options appraisal and dealing with risk and uncertainty.
- Hallegatte et al. (2012) “*Investment Decision Making under Deep Uncertainty — Application to Climate Change*”. A detailed and technical summary of the state-of-the-art in decision making under uncertainty applied to climate change adaptation.
<http://elibrary.worldbank.org/content/workingpaper/10.1596/1813-9450-6193>
- Walker et al. (2012) An accessible review of the history of scenario planning and robust decision making, with examples.
- Wilby et al. (2012) A detailed review of climate information for adaptation planning.



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Glossary

Taken from the IPCC Fourth Assessment Report and IPCC (2012):

adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

adaptive capacity: The ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies.

anticipatory adaptation: Adaptation that takes place before impacts of climate change are observed.

autonomous adaptation: Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.

climate change: Climate change refers to any change in climate over time, whether due to long-term natural variability or as a result of human activity.

disaster: Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency responses to satisfy critical human needs. External support for recovery may also be required.

disaster risk management: Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience and sustainable development.

emissions scenario: A plausible representation of the future development of emissions based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships.

planned adaptation: Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state.

resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

risk: The product of potential impact and its probability.

vulnerability: The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. It is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity.

Raimond Duijsens
Coordinator Partners for Resilience

It is with great interest that I read your call regarding the quest for evidence that will inform the Human Resilience to Climate Change and Disasters policy project. I believe the experience of the Partners for Resilience programme (www.partnersforresilience.nl) may provide such evidence.

The programme, co-funded by the Dutch Ministry of Foreign Affairs and implemented in nine countries by humanitarian, development, climate change and environmental organisations and their partners, seeks to strengthen community resilience of several hundred thousand people over the course of five years. Started in 2011 and with a budget of 40 million Euros it is one of the first and most extensive programmes of its kind. It combines knowledge from the fields of climate change and ecosystem management and restoration with disaster risk reduction and looks for ways to best integrate these three fields into an effective approach to strengthen the livelihoods of people who are vulnerable to disasters. The programme has developed its vision on resilience, defining four building blocks and seven key principles. Communities will need to be strengthened to anticipate the risks they face, respond when disaster strikes while maintaining basic infrastructure and functions, adapt to changing risks and as a final stage transform themselves to address underlying factors and root causes of risk. The approach of Partners for Resilience helps communities to move beyond 'business as usual' when addressing disaster risk. Key principles are working on different timescales, recognising broader geographical scales, strengthening institutional resilience, integrating disciplines, applying self-management, stimulating learning, focusing on livelihoods, and finally forming partnerships with various stakeholders.

Being in its third year of implementation the programme has yielded some first results on each of the eight key principles. An overview of cases is presented at our website (http://www.partnersforresilience.nl/about-us/documents/nlrc_pfr_vision%206p%20web.pdf), and more evidence is building up. In parallel with the implementation we also have embarked on a learning trajectory, teaming up with two universities in the Netherlands, to assess what elements are of particular importance in relation to achieving success, be it in the approach or in the institutional environment. This project has recently started and we expect to have first findings mid 2014.

We hope that, although briefly highlighted, the approach and findings of our programme can contribute to your policy project and answer to a substantial number of your specific questions, and we will be more than happy to further engage with you and share more of our experience.

Multiple Vulnerability Indices as a Tool for Prioritizing Adaptation Interventions: Case Study of Assam, North East India

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Climate change could impact a whole sector, state or a country and planned adaptation interventions will have to be prioritized spatially at various scales; village, blocks, districts and states or according to sectors. The information on climate change projections or impacts alone for a given sector such as agriculture may not be adequate for initiating adaptation interventions. The impact or the severity of the impact is determined by climate change related impacts as well as natural resource and socio-economic endowments. Vulnerability assessment would enable consideration of the impact of climate variability or climate change as well as natural resource and socio-economic endowments in identifying, ranking and prioritizing locations (village, block, districts, etc.), sectors (agriculture, water, forests, etc.) and communities (rainfed farmers, coastal communities, etc.) for adaptation interventions.

Vulnerability Assessment - A Precursor to Adaptation Interventions

IPCC (2007) provides a framework for vulnerability assessment which is the first step for adaptation interventions. According to this framework, vulnerability is a function of three components namely, exposure, sensitivity and adaptive capacity. Vulnerability assessment involves developing an index for the three components and their aggregation. Further, each of the three vulnerability components requires a large number of bio-physical and socio-economic indicators, their measurement, normalization, weighing, and aggregation.

Vulnerability indices could be developed focusing only on the socio-economic or bio-physical aspects of a system, or by considering both these factors. In literature, majority of the vulnerability assessments are focused on socio-economic factors. Here we provide examples, focusing largely on demographic and socio-economic indicators.

Eidsvig et al. (2011) assessed the socio-economic vulnerability to natural hazards such as landslides. The indicators considered in this study were demographic, economic and social characteristics as well as indicators representing the degree of preparedness and recovery capacity.

Pandey and Jha (2011) developed a climate vulnerability index for rural lower Himalaya. The index consisted of household parameters spanning Exposure, Sensitivity and Adaptive capacity and included a large number of socio-demographic, livelihood, health, water, social networking, food, climate variability and natural disturbance related indicators.

Luxon and Pius (2012) developed climate change risk and vulnerability mapping and profiling at local level using the household economy approach using wealth related indicators such as land holdings, livestock holdings, capital, education, skills, and labour availability.

Sietz et al (2012) developed smallholder vulnerability patterns to weather extremes with regard to food security in the Peruvian Altiplano based on indicators such as crop area, crop productivity, livestock units, education level and off-farm incomes.

Multiple Vulnerability Indices: Case Study of Assam, North East India

A case study of Assam is presented here where multiple vulnerability indices, covering both bio-physical and socio-economic aspects were developed and compared at the district level. Assam is the largest state in North East India with 23 districts, and a population of about 26 million, and 80% are rural. The state is characterized by hilly mountainous regions, valleys and is highly prone to floods.

The vulnerability indices developed and indicators used in this study are as follows (Ravindranath et al (2011) and Nair et al (2013):

- *Agricultural Vulnerability Index (AVI)*: Relative variability of rainfall, percentage inter-annual variability of rainfall, area under rainfed/dryland crops, rural population density, number of agricultural land holdings less than 2 ha, net sown area, area under irrigated crops, area under high-yielding varieties, amount of fertilizers consumed, amount of manure used, net annual groundwater availability, mean rainfed crop yield
- *Water Resource Vulnerability Index (WVI)*: Water availability, crop water demand, drought indicator, flood discharge
- *Forest Vulnerability Index (FVI)*: Disturbance, fragmentation status, biodiversity richness
- *Poverty Vulnerability Index (PVI)*: urban–rural population ratio, per-capita income, number of livestock owned per household, Gini Coefficient of income and literacy rates.

The districts were ranked on a scale of 1-5 as i) very highly vulnerable (4-5), ii) highly vulnerable (3-4), iii) moderately vulnerable (2-3), iv) low vulnerable (1-2) and v) very low vulnerable (>0-1). The vulnerability indices for the above four types were developed at district level and are grouped on a scale of 1 to 5. The distribution of districts on the vulnerability scale is presented in Table 1. It can be observed that the distribution of districts for different vulnerability indices varied on the vulnerability scale of very low to very high. Only North Cachar district was ranked as very highly vulnerable for AVI, whereas when WVI is considered, 12 districts were ranked as very highly vulnerability districts. When PVI is considered, only three districts were ranked as very high. Overall vulnerability index computed using all the four vulnerability indices showed only three districts ranking as very highly vulnerable and interestingly, only one district namely Dhubri has also been ranked on the same scale for PVI and WVI.

Table 1: Districts ranked according to agriculture, water, forest, poverty and overall vulnerability indices

| | Agricultural vulnerability index | Water resource vulnerability index | Forest vulnerability index | Poverty vulnerability index | Overall vulnerability index |
|--|----------------------------------|------------------------------------|----------------------------|-----------------------------|-----------------------------|
| | | | | | |

| | | | | | |
|---------------------------------------|---|---|--|--|--|
| Very high vulnerable districts (4-5) | North Cachar Hills | Nalbari, Barpeta, Dharang, Dhubri, Sibsagar, Jorhat, Golaghat, Sonitpur, Marigaon, Kamrup, Goalpara, Bongaigaon | | Nagaon, Kokrajhar, Dhubri | Dhubri, Marigaon, Nagaon |
| High vulnerable districts (3-4) | Dhemaji, Tinsukia, Nalbari, and Barpeta | Kokrajgar, Karbi Anglong, Nagaon, Dhemaji, Dibrugarh, Lakhimpur | Dibrugarh | Hailakandi, Dhemaji, Darrang, Marigaon, Nalbari, Barpeta | Jorhat, Sibsagar, Tinsukia, Nalbari, Bongaigaon, Kokrajhar |
| Moderately vulnerable districts (2-3) | Dharang, Lakhimpur, Dhubri, Dibrugarh | Tinsukia | Dhubri, Goalpara, Marigaon, Jorhat, Sibsagar, Tinsukia | Karimganj, Lakhimpur, Bongaigaon, Goalpara | Hailakandi |
| Low vulnerable districts (1-2) | Sibsagar, Jorhat, Golaghat, Sonitpur, Nagaon, Marigaon, Karbi Anglong, Kamrup, Goalpara | - | Nalbari, Barpeta, Dharang, Golaghat, Sonitpur, Kamrup, Bongaigaon, Kokrajgar, Karbi Anglong, Nagaon, Dhemaji, Lakhimpur, Tinsukia, Karimganj, Hailakandi, Cachar, North Cachar | North cachar, Cachar, Karbi Anglong, Golaghat, Sonitpur, Dibrugarh, Tinsukia | Barpeta, Dharang, Golaghat, Sonitpur, Kamrup, Karbi Anglong, Dhemaji, Lakhimpur, Tinsukia, Karimganj, North Cachar |
| Very low vulnerable districts (>0-1) | Kokrajhar, Karimganj, Hailakandi, Bongaigaon, Cachar | Karimganj, Hailakandi, Cachar, North Cachar | | Jorhat, Sibsagar, Kamrup | Karimganj, Cachar |

We would like to highlight two issues in the context of development and utilization of vulnerability indices for prioritizing adaptation interventions. Firstly, it is very important to consider both bio-physical and socio-economic indicators in developing a vulnerability index (Ravindranath et al., 2011 and Seitz et al., 2011). Secondly, different vulnerability indices lead to differing set of districts categorized on a vulnerability scale of very high to very low. Thus identification and prioritization of spatial units for adaptation intervention could be based on sectoral vulnerability index targeted at specific sectors such as agriculture, water, forest, etc. Alternatively, multiple vulnerability indices could be developed and aggregated based on weightage given by stakeholders.

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The Fourth IPCC Assessment report (2007) predicts severe stress on the already stressed ecosystems of India – ranging from increased drought and river system closure to reduced flows in Himalayan river systems to extreme precipitation events to changes in crop yields and reduced ecosystem resilience. India has experienced a series of natural climatic events which fall outside the usual natural variability and are likely to be associated with climate change.

Merely on the basis of population projections and with the assumption that the availability of water resources shall not change in future, the per capita surface water availability in India on the basis of census of 1991 and 2001 works out to be 2,309 and 1,902 cu.m which is projected to be 1,401 and 1,191 cu.m for the years 2025 and 2050 respectively (NCIWRD, 1999).

The Ministry of Water Resources (MoWR) has declared that there is nothing to worry about our water requirements at least till 2050 if we enhance water use efficiencies and indulge in demand management. It is important to note that two very crucial factors had been ignored in making these projections. Firstly the impact of programmes such as watershed management on the water resources has been ignored completely, maybe assuming that it shall have an insignificant impact. Secondly, the analysis does not take into account any possible impact due to climate change while making the future projections. The picture shall completely change if these two aspects are taken into consideration. Furthermore, there has been no attempt to enumerate the ecosystem services being provided by these freshwater systems. The possible reason behind such a drawback is that these assessments have been made by conventional water resources engineers, who have always indulged in the process of water resources development without bothering much about ecosystem services rendered by the system.

In India, a very large extent of development in land and water resources is also taking place through a parallel mechanism and at the scale of very small areas in the form of watershed management. Although considered to be a benign development, it has far reaching consequences if not handled properly.

The Ministry of Rural Development (MoRD, 2004) spearheads the watershed management programme that has the following objectives for projects taken under the scheme:

- i. Harvesting every drop of rainwater for purposes of irrigation, plantations including horticulture and floriculture, pasture development, fisheries etc. to create sustainable sources of income for the village community as well as for drinking water supplies.
- ii. Ensuring overall development of rural areas through the 'Gram Panchayats' (village councils) and creating regular sources of income for the Panchayats from rainwater harvesting and management.
- iii. Employment generation, poverty alleviation, community empowerment and development of human and other economic resources of the rural areas.
- iv. Mitigating the adverse effects of extreme climatic conditions such as drought and desertification on crops, human and livestock population for the overall improvement of rural areas.

- v. Restoring ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover especially plantations.
- vi. Encouraging village community towards sustained community action for the operation and maintenance of assets created and further development of the potential of the natural resources in the watershed.
- vii. Promoting use of simple, easy and affordable technological solutions and institutional arrangements that make use of, and build upon, local technical knowledge and available materials.

All the objectives except the first one, where the intention is to harvest every drop of water, are very legitimate and can be pursued effectively provided an elaborate mechanism to implement such objectives is put in position. However, if one goes through the complete set of recommendations it may be realized that all the recommendations are mainly geared towards ensuring proper utilization of funds having fixed a rate of development apriori (Rs 12,000 per hectare presently). It may be debated that it is only a mechanism of arriving at a figure which can be taken as the maximum cap, but there will be hardly any project where less than this figure has been disbursed. This is one single reason that most of the watershed projects have landed up with interventions that can consume maximum funds, such as check dams, irrespective of the facts whether they are justified or not.

As far as the first objective is concerned, the intent to harvest every drop that falls over the area shall be dangerous from an ecological and environmental angle. It has the capability of bringing about biophysical changes to the extent that the total character of the existing hydrological regime is changed. As a consequence, there might not remain any surface flow available any more to the downstream areas (Gosain and Calder, 2003). It must be understood that every area has a prevalent water balance and any intervention caused is bound to change its water balance, the extent of which is dictated by many factors including the local biophysical characteristics and weather conditions. It is unfortunate that the emphasis in watershed development programmes is still firmly based on the belief that water is essentially an infinite resource and can be managed through the continual development of groundwater abstraction together with the implementation of water harvesting projects (KAWAD, 2001).

The present implementation of the watershed management programmes in India has many shortcomings. Some of the major ones include:

- Invariably ignoring the hydrological boundaries of the watersheds
- Ignoring the connectivity of the watersheds and treating each watershed as a stand alone unit, where activities within the watershed are considered independent of their impacts downstream
- Ignoring the hydrological characteristics of the watershed while deciding on the possible interventions
- Non-availability of the quantitative evaluation procedures, and
- Ignoring the environmental sustainability aspects.

The changes in land use, which may be promoted as part of watershed development programmes, may reduce the availability of water for downstream users. In arid areas, where water is already scarce, this can have profound impacts on more vulnerable groups. Moreover, these land use changes can result in rivers drying out completely,

having significant impacts on the functioning of aquatic ecosystems (Calder et al, 2004a).

Very recently, the MoRD had realised this and has launched another programme by the name 'Neeranchal' wherein it is intended to use the river basin as the hydrological unit to assess the impact of proposed watershed measures on the water balance and the environmental functions in an integrated manner.

Such initiative shall support policy improvement, and in particular implementation, evaluation, linkages between policies and consideration of the effects on ecosystems. Research organisations and networks may be best placed to take the initiative on these issues, and in particular to communicate research information to policymakers in appropriate ways. Research priorities also include support for governance. Research infrastructure should include a framework for integration, planning, monitoring and assessment. Within this, a series of components are required for addressing technical, environmental and social issues as well as support in negotiation and community participation.

If India can pay attention to these requirements that shall help in adapting to the present variability of the water resources then it shall be much better placed to cope with the implications of the climate change. The group at IIT Delhi along with INRM Consultants (a startup company incubated by IIT Delhi) has spearheaded the climate change impact assessment on the water resources of India in both the communications made by India to UNFCCC (NATCOM, 2004 and 2012) (Gosain et al., 2006; 2011). The hydrological modelling results of these two communications have been disseminated through the link <http://gissserver.civil.iitd.ac.in/natcom>

Formulation of strategies to cope with the climate change impacts is very crucial. The HighNoon EU project, in which IIT Delhi was a key participant, engaged in the assessment of the impact of Himalayan glaciers retreat and possible changes of the Indian summer monsoon on the spatial and temporal distribution of water resources in Northern India, and provided recommendations for response strategies to strengthen the cause for adaptation to hydrological extreme events.

An indicator framework was developed to evaluate the impacts of proposed adaptation measures in northern India. The indicators were used to describe the current status of land and water resources and to assess the effectiveness of adaptation measures across scales and sectors.

http://www.innovationseeds.eu/Virtual_Library/Results/HighNoon_Indicator_Framework_Tool.kl

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Response by - Dr.Indrila Guha

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1. How will weather-related hazards change in their frequency, intensity and location to
a) 2030 and b) 2100?

- Ans.: a) Severe and super cyclonic storms are increasing in frequency and intensity during recent years in the northern Bay of Bengal, which creates an alarming situation for Indian Sundarbans (S. Hazra, 2010).
- b) Severe Cyclonic Storms over Bay of Bengal registered 26% increase over last 120 years, intensifying in post monsoon, (Singh, 2007).
- c) Frequency and intensity of floods increases in Indian Sundarbans (C. Roy and I. Guha, 2013).

2. Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

- Ans.: a) Floods have the largest impacts on people. “More people die from floods each year than from tornadoes, lightning, or hurricanes”. <http://www.nc-climate.ncsu.edu/edu/k12/.SevereWeather>
- b) Cyclone Aila in 2009 displaced 2.3 million people in India (Bhattacharyya, A et al., 2012).
- c) In Indian Sundarbans, 4 islands have been submerged and nearly 6,000 families became homeless and turned into environmental migrants (WWF India, 2009).
- d) By 2020, more than 30,000 people residing in Sagar Island (Indian Sundarbans) will be displaced from their existing habitat (Hazra, 2002).

- e) With declining land mass and growing population food security is threatened. The decline in food security and the lack of other developmental choices in the face of climate variability is a serious threat to the economic viability of population in the Sundarbans (C. Roy and I. Guha, 2013).
- f) Average loss of assets of the climate migrants is INR 1.826 million per family. Lots of people have lost their original gainful livelihoods and switch to uncertain and high life risk livelihoods (C. Roy and I. Guha, 2013).
- g) By 2030, thousands of people residing in Indian Sundarbans will be displaced from their existing habitat, degree of poverty will be increased, natural and human capital will be degraded due to coastal erosion, tidal waves and flooding (C. Roy and I. Guha, 2013).

3. What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

Ans: Resilience is the capacity to withstand stress and catastrophe. Psychologists have long recognized the capabilities of humans to adapt and overcome risk and adversity. Individuals and communities are able to rebuild their lives even after devastating tragedies. People in our case study sites have done so by taking salt resistant crops when fertility became less due to aila and salt water intrusion in agricultural fields. They tried for multiple cropping pattern etc.

4. Who are the real adaptation decision-makers / where are adaptation decisions really made?

Mainly government ideally taking experts views in consideration but often they fail to do so. We, the researchers try to disseminate knowledge by calling them to share our findings from ground truth (based on focus group discussion and primary survey)

5. What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

Ans: Using three indices we can assess the vulnerability and take true adaptation strategies (C. Roy and I. Guha, 2013),-

- a) *Vulnerability Indices based on Livelihood (VIL)*: Such as loss of original livelihood and decline in monthly family expenditure.
- b) *Vulnerability Indices based on Food Security (VIF)*: Such as loss of crops and fishery, and decrease in monthly food expenditure.
- c) *Vulnerability Indices based on Empowerment (VIE)*: Such as increase in dropout children, water borne diseases and scarcity of drinking water.

The policymakers and practitioners can choose and implement the most appropriate adaptation measures based on three indices.

6. What are the most commonly discussed and implemented adaptation approaches for protecting against, reducing sensitivity to, and allowing recovery following, weather-related hazards?

Ans.: To reduce and protect of the loss/damage of assets of the climate migrants in Indian Sundarbans we suggests few adaptation strategies,-

- a) Enhancement of proactive migration: those who migrated in anticipation based on past experiences
- b) Mangrove Plantation in Scientific Way
- c) Strengthen Embankment
- d) Improved job opportunity: Encourage self employment that will be supplement of existing ones.

7. Are there any studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?

Ans.: MRC Technical Paper (December 2010), “*Review of climate change adaptation methods and tools*”, No 34.

<http://www.mrcmekong.org/assets/Publications/technical/Tech-No34-Review-of-climate-change.pdf>

8. To what extent, and under which circumstances, can ecosystem-based approaches be integrated with other adaptation approaches (eg. those that involve hard infrastructure, technology and social interventions)?

An integrated approach will be very useful

9. In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?

10. To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?

Ans.: Ailbhe Travers, Carmen Elrick, Robert Kay and Ole Vestergaard (April 2012).

http://www.unep.org/climatechange/adaptation/Portals/133/documents/Ecosystem-Based%20Adaptation/Decision%20Support%20Framework/EBA%20Guidance_WORKING%20DOCUMENT%2030032012.pdf

11. What are the appropriate scales for, constraints, distributional consequences and trade-offs of ecosystem-based approaches?

Royal Society Working Group**Human Resilience to Climate Change and Disasters project****Call for Evidence****Submission by Healthy Soils Australia**

Thanks for the opportunity to contribute to your review of this important topic.

Healthy Soils Australia and our associated initiative Soils for Life has had an extensive focus on our need to urgently regenerate the health and resilience of our soils and landscape as a key practical action to seek to help buffer pending climate extremes, cool regional climates and secure the critical water, food and eco-system needs for many communities in the decades ahead. Further background on this are provided via the Soils for life website, the recent attached paper to the Royal Society in Victoria and our paper to the Radical Emissions Reduction conference at the Society in December.

In response to your questions in the call for evidence; our experience is;

1. How will weather related hazards change by 2030?

Based on Bureau of Meteorology and CSIRO data much of Australia has been undergoing serious systemic aridification for many decades, even before CO₂ levels increased abnormally as a result of;

- The expansion of Hadley high pressure cells that have displaced the cool moist Ferrel cells that provided much of the winter rainfall to southern Australia southward since the 1970s.
- The weakening of east coast humid onshore trade winds and their extension inland over the past century.
- A more irregular but occasionally stronger NW Australian Monsoon from the Indian Ocean.

As a result much of southern, inland and even northern Australia is aridifying and at risk of more frequent, severe and extensive wildfires that because of higher exotic fuels and the demise of natural herbivore and aboriginal control burning threatens the collapse of key bio-systems.

2. Hazards of largest impact on people and their projected changes and impacts by 2030.

Whereas wild fires have burnt some 30 mha/an for long periods, due to the aridification, increased fuel levels and loss of ecological fuel reduction the extent and impact of wildfires can be expected to increase greatly threatening many bio-systems and with that the viability of many communities and land uses dependent on them for their sustained water, food and eco-system services values.

3. Key components of human/social resilience impacted by these changes.

While naturally uniquely adapted to a dry variable climate, many of the bio-systems being impacted by these extremes are unlikely to be able to sustain the buffered mesic conditions that they have created leading to the loss of their ability to secure water, food, shelter and bio-habitat values. This will impact communities and economies via health and social stability declines.

4. Adaptation decision makers and their location.

The viability of current land uses and communities will depend fundamentally on the capacity of local farmers and land managers and decision makers to adapt innovative practices, such as those documented in the Soils for Life case studies, to sustain these bio-systems and their outputs despite the stresses. These decisions will be made at local/regional levels often with social delays built in. Policy interests may fail to see the stresses responding to symptoms well after the system collapse.

5. Assessment tools and decision making frameworks to help policymakers.

The critical tools for assessing the stresses in and viability of such landscapes relate to the ability of these bio-systems to infiltrate, retain and efficiently use the lower less reliable rainfalls in their soils and how past and current land management practices have impaired these. This will substantially govern the longevity of green growth able to be sustained by these bio-systems and their capacity to buffer and resilience to stress. It will govern what land uses can be sustained for how long and how vulnerable they are to stress and collapse. While informed local practitioners may be able to use these tools for wise decision making most policymakers may not have such ecological insight.

6. Effective adaptation approaches.

Consistent with the above natural determinants governing the resilience of these bio-systems their ability to adapt to such stresses depends on their residual; soil carbon content, structure, ability to retain rainfalls, shelterwood protection and ability to sustain the longevity of green growth. Their regeneration similarly needs to focus on restoring their soil carbon and thus resultant resilience.

7. Case studies of the success of such strategies relative to controls.

The Soils for Life case studies detail practical examples from throughout Australia of how the resilience of bio-systems have been regenerated via a range of innovative ecological practices and how this has delivered outcomes relative to conventional practices at farm, regional and sub sector levels and on social, economic and ecological criteria. Our focus now is on how best to catalyse the wider adoption of such practices and outcomes relative to the protected degrading status quo.

8. Integration of ecological and economic adaptations and interventions.

The case studies and subsequent initiatives reinforce why regeneration needs to focus on restoring the natural ecological processes to rebuild the health, productivity and resilience of bio-systems with hard infrastructure or technology interventions being justified and specified where they can catalyse or support some needed process. For example recent initiatives to regenerate the resilience of bio-systems over 300m ha of inland and northern Australia involve the creation of additional reliable dry season stock water sources primarily to remove pressures from natural water habitats and to help control the fuel, wildfire fire and feral animal impacts via the better management of herbivores. Without this additional water natural water habitats would be degraded by overgrazing while vast unwatered areas would be degraded by far more intense and extensive wildfires.

9. The optimal criteria for assessing different approaches.

Clearly the assessment criteria need to be relevant to the specific regeneration and resilience building objective for each project. In all cases assessments should be based on the full externality

costs and benefits of the resilience versus the status quo approaches. For many Australian projects the criteria often becomes existential, can that bio-system survive under business as usual.

10. To what extent are ecosystem based approaches needed.

In most cases in Australia the only way bio-systems can be regenerated and sustained given the increased stresses is via restoring the natural ecological soil, microbial and vegetation processes that governed the evolution and survival of these bio-systems over the past 80 million years.

11. What are the appropriate scales for effective initiatives.

To be effective innovative regeneration initiatives are often best managed at a local-group scale where the innovators can access adequate peer support and critical mass but are not impeded grossly by excessive planning, regulation, compliance and overheads. Even with seed funding they need to remain commercial and market focused to be able to create and capture value and incomes to sustain activities as soon as possible. Once documented and demonstrated as successful public seed funding is justified to aid their extension to other groups, regions and related sub-sectors.

We hope the above is of assistance to your review. Please contact me if we can be of any further help on any of these issues. The Soils for Life website and the attached papers provide further details of our experience in trying to regenerate the resilience of bio-systems and communities in the face of these intensifying and pending climate extremes.

Walter Jehne

Healthy Soils Australia



Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

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Weather-related hazards have become larger in scope, frequency and intensity (IPCC, 2012). However, their impact on disaster risk is not only dependent on the hazard, but on socioeconomic conditions, such as levels of poverty, effective governance systems and the prevalence of conflict¹. It is a challenge to discuss which weather-related hazards have the largest impact on people, as this is dependent on locality and situation – and is contingent on people’s vulnerability to that hazard, their ability to withstand the shock and their capacity to respond; what some may term their ‘disaster resilience’ (DFID, 2011). In a recent report entitled the [geography of poverty, disasters and climate extremes in 2030](#) (Shepherd et al., 2013), the authors examine the relationship between disasters and poverty, and found that:

- Extreme weather linked to climate change is increasing and will likely cause more disasters. Such disasters, especially those linked to drought, can be the most important cause of impoverishment, cancelling progress on poverty reduction.
- Up to 325 million extremely poor people will be living in the 49 most hazard-prone countries in 2030, the majority in South Asia and sub-Saharan Africa.
- The 11 countries most at risk of disaster-induced poverty are Bangladesh, Democratic Republic of Congo, Ethiopia, Kenya, Madagascar, Nepal, Nigeria, Pakistan, South Sudan, Sudan, and Uganda.
- Disaster risk management (DRM) should be a key component of poverty reduction efforts, focusing on protecting livelihoods as well as saving lives. There is a need to identify and then act on where the poor and disaster risks are most concentrated.
- The post-2015 development goals must include targets on disasters and climate change, recognising the threat they pose to the headline goal of eradicating extreme poverty by 2030.

Evidence from the report found that the most catastrophic individual weather-related disaster events, in terms of direct impacts on housing, are tropical cyclones; whereas droughts, regional floods and large volcanic eruptions have the greatest impact on agricultural livelihoods. Evidence suggests that of all the hazards analysed in this report, drought was linked most closely to poverty (Shepherd et al., 2013).

It is important to distinguish between the differentiated impacts on individuals from slow onset events (such as changing temperatures and sea-level rise) and rapid onset events/shocks (such as cyclones and

¹ See: Harris et al., 2013



flooding). Extreme and rapid onset events can have devastating impacts, as can be seen by the recent Typhoon Haiyan in the Philippines where over 2,500 people have been killed, and early estimates indicate 700,000 people have been displaced. In contrast, slow-onset disasters result in gradual changes over the longer-term and can often lead to a sustained negative impact over months or even years. This can cause extensive risk which results in a much greater impact on communities as vulnerability is increased and resilience undermined. For example, in the Sahel over 18 million people were affected by the 2012 food crisis as a result of drought, failure of crops and rising food prices (Oxfam, 2013) which resulted in many adverse coping mechanisms. Drought causes significant detrimental impact with major implications on water and chronic food insecurity; this often exacerbates existing conflict and insecurity within countries, including in the Sahel. In turn this increases people's vulnerability to weather-related hazards, and undermines development progress more generally. Weather-related hazards and changes in precipitation and temperature can also pose a threat to people's livelihoods and health through secondary impacts including an increase in disease, changes in soil and so on.²

How is exposure and vulnerability to such events likely to change from now until 2030?

Disasters already affect millions of people and destroy infrastructure, assets and livelihoods. Globally, 'exposure is increasing as more people and assets are located in hazard-prone locations' (Mitchell et al., 2012 *in*: Mitchell, 2012; 7). This is often as a result of population growth, higher mobility towards coastal and urban locations³, and the degradation or loss of natural ecosystems (Mitchell *et al.*, 2012; Foresight, 2012; IPCC, 2012). Disaster risk is expected to continue increasing as 'vulnerability, exposure and the frequency and severity of many hazards' are influenced by such factors (Mitchell et al., 2013; 3). It is apparent that 'unless something changes – and changes fast – up to 118 million extremely poor people in sub-Saharan Africa will be exposed to drought, flood and extreme heat hazards alone in 2030'⁴ (Shepherd et al., 2013 ; ix).

Disasters can reverse years of development gains, preventing us from reaching international efforts to eradicate poverty by 2015 when the MDGs and HFA come to an end (Mitchell et al., 2013). It is important that DRM is explicitly included in the post-2015 development agenda in order to ensure a new global compact addresses the risks that developing countries face. To complement this, ways need to be found to incentivise investment in advance of shocks to protect lives and livelihoods; a recent ODI [report](#) examines three scenarios: a standalone goal on disasters, supported by targets; a target on disasters within a goal on 'resilience', 'security' or 'tackling obstacles to development'; and an integration of DRM into other goals. The report highlights the value-added of including DRM in poverty reduction and education goals, and options for doing so.

Knowledge gaps

A number of gaps in the evidence base currently exist, which require further research:

- a) Data on disaster impacts and risks vary considerably in quality and quantity. Longitudinal studies including better datasets and baselines are needed to assess changes in the level of disaster risk over time. Focus should be placed on assessing slow-onset disasters, which often go uncounted

² See: Wilkinson et al., (2012)

³In 2010 over half the world's population lived in urban areas. This figure is increasing by 60 million every year, and it is estimated that by 2030, 60% of the world's population will live in a city (WHO, 2013).

⁴Chad (4-5 million), Central African Republic (3 million), Democratic Republic of Congo (20-30 million), Ethiopia (12-22million), Liberia (1-2 million), Nigeria (14-22 million), Uganda (3-6 million) are countries with the highest concentrations.



(UN/ISDR, 2009).⁵ It is also important that longitudinal studies assess the link between ‘natural’ disasters, poverty and impoverishment (Shepherd et al., 2013).

- b) A deeper understanding of why, how and under what circumstances action is taken (by policy makers, practitioners and communities) to reduce disaster risk and build resilience.⁶ This includes opportunities and barriers for DRM under different governance contexts; including states affected by conflict and fragility (Harris et al., 2013).
- c) More research is needed to ‘identify a suitable indicator framework that is able to probe vulnerability and exposure to drought in a more refined way’ (Shepherd et al., 2013).
- d) Better data and understanding is needed of hazard risk, poverty levels and DRM at sub-national levels, particularly for larger countries, such as India, where there is such diversity in terms of exposure, risk and vulnerability to hazards (Shepherd et al., 2013).
- e) DRM needs to be included in the post-2015 development agenda, more work is needed to see how this can be done successfully and in a coherent manner (Mitchell et al., 2013).

⁵ See: Wilkinson et al., (2012)

⁶ See: Wilkinson et al., (2012)



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Being optimistic about the Future: avoiding maladaptation to climate change

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1. INTRODUCTION

Many initiatives labelled as “climate change adaptation¹” initiatives are now seeing the light of day in both developing and developed countries. They cover a wide array of territorial levels: ranging from projects developed at the micro-local level to national policies and regional initiatives (Pacific, Europe, South-West Indian Ocean, etc.). At the international level, also, negotiators are debating the amounts and architecture of global funding for adaptation. This indicates a growing awareness over the last two decades of how important the adaptation component has become in the fight against climate change. Albeit encouraging, it is not enough since the methods and specific components required to implement adaptation remain relatively obscure (Hinkel 2011, Dupuis and Biesbroek *in press*). What constitutes a “good” project or a “good” adaptation policy?

To adapt implies maintaining or strengthening resilience against current disruptions, on the one hand, and being capable of planning for the long term, on the other (Cardona *et al.* 2012). The latter point, in particular, involves wagering on the future benefits of initiatives that are committed to today. However, it is extremely difficult to know in advance whether an initiative undertaken now will meet the challenges of tomorrow. Added to this, of course, is the uncertainty related to the intensity and frequency of future impacts of climate change at the local and regional levels (Meehl *et al.* 2007, Stocker *et al.* 2013). Beyond the aims set down “on paper”, the recurring question therefore is how to adapt to changes that cannot yet be precisely defined. When developing initiatives, there is thus a strong temptation to wait for science (of climate impacts and vulnerability) to provide more precise information. While this wait-and-see stance is in some ways understandable, it is untenable. Firstly, because it is far from sure that uncertainty will diminish with time, for three main reasons: *(i)* advances in climate science may lead to increased uncertainty, especially when new processes are identified (feedback between parameters and turning points – Alley *et al.* 2003); *(ii)* the magnitude of future climate change will greatly depend on future greenhouse gas emissions, and consequently on decisions not yet taken; and *(iii)* future impacts will affect future societies whose precise characteristics we cannot identify decades in advance. Next, because taking on the challenge of climate change implies a fundamental change in our development paths and our relationship with environmental constraints. Such changes, however, require time and must be initiated as quickly as possible if they are to have a chance of being effective.

In this context, a useful starting point would be to focus attention not on defining the characteristics of “ideal” adaptation but rather on the characteristics that will help avoid maladaptation to climate change; or at least not exacerbate problems in the future. This is a first step towards adaptation in the broader sense, and this paper puts forward some guiding principles to this end.

2. DEFINING MALADAPTATION TO CLIMATE CHANGE

The use of maladaptation as a concept in the sphere of climate change mainly dates back to the late 1990s. Scheraga and Gramsch (1998) refer to it indirectly through nine principles that characterise effective adaptation, including the importance of accounting for “potential adverse side effects of adaptive strategies... to avoid solutions that are worse than the problem” (p.85). According to them, “maladaptation can result in negative effects that are as serious as the climate-induced effects being

¹ For ease of reading, we will refer here to “adaptation” and “maladaptation”.

avoided” (p. 87). The term also appears in the IPCC’s Third Assessment Report, which defines maladaptation as “an adaptation that does not succeed in reducing vulnerability but increases it instead” (McCarthy *et al.* 2001: 990). Smithers and Smit (1997) and Schipper (2009) also mention the term maladaptation in their work. More recently, Barnett and O’Neill (2010 – see also Barnett and O’Neill 2013, Barnett *et al.* 2013), while focusing on responses to water stress engineering in the city of Melbourne (Australia), refer to “an action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups” (p. 211). In November 2012, 16 experts held a 3-day workshop² on the maladaptation issue and came up with the following definition:

Maladaptation is a process that directly results in increased vulnerability to climate variability and change, and/or undermines capacities or opportunities for present and future adaptation.

Maladaptation refers to an initiative (e.g., policy, plan, project) initially designed for adaptation but that in fact has adverse effects either on the socio-ecological system in which it is developed, or on another one, or both.

When speaking of a process, this definition reflects the various timescales for implementing adaptation, including initiatives implemented today but which may later have adverse effects. The definition thus invites us to go beyond the problem of uncertainty about future climate and environmental conditions to consider the potentially adverse effects of an initiative that may be taken now in the name of adaptation. In other words, and based on the now widely shared view that climate change will essentially exacerbate already known problems (Parry *et al.* 2007, Cardona *et al.* 2012), an initiative may not be considered as adaptation if it does not significantly and directly reduce the system’s current and future vulnerability to natural hazards. In brief, this means restricting societies’ exposure to existing hazards (e.g., avoiding urbanisation too close to shorelines), limiting the sensitivity of the ecosystems to current climate stress (e.g., rehabilitating coastal sand dunes) and strengthening current societies’ adaptive capacities (e.g., improving risk management systems). This reflects the three pillars (exposure, sensitivity and adaptive capacity) of IPCC’s definition of vulnerability to climate change. Except that here, the entry point is the reduction of current constraints, with the underlying idea that these constraints are potential vectors of maladaptation to climate change.

At the end, the above definition considers maladaptation as a pathway, limits it to the direct detrimental effects of an adaptation initiative on the system’s vulnerability to climate variability and change, links it to the necessity of keeping manoeuvre rooms in order to face current and future climate-related environmental changes, and emphasizes its multi-scale nature (both spatial and temporal). In doing so, it indirectly highlights two key messages: first, that “doing no harm” is a prerequisite for any adaptation process; second, that the maladaptation gateway is a positive way to think about adaptation as it allows being pragmatic.

3. GUIDING PRINCIPLES TO AVOID MALADAPTATION

Based upon this frame, one can affirm that adaptation requires that the climate change dimension (i.e., extreme events and gradual changes) be central to a broader approach to sustainable development (preserving the environment, reducing people’s exposure to natural hazards, etc.). This can be expressed in concrete terms by 11 guiding principles that are primarily aimed at avoiding environmental, social and economic maladaptation (Table 1). We argue here that because these

² November 6-9, 2012 at the Rockefeller Foundation centre in Bellagio, Italy. Attendees (in alphabetical order): S. Anderson (IIED, UK), S. Bharwani (SEI, Sweden), F. Briones (CIESAS, Mexico), M. Burkett (University of Hawaii, USA), I. Burton (University of Toronto, Canada), S. Eriksen (University of Oslo, Norway), F. Gemenne (Iddri, France), A. Magnan (Iddri, France), J. Schaar (Swedish International Development Cooperation Agency, Sweden), L. Schipper (SEI, USA), M. Mortimore (Ahmadu Bello University and Bayero University, Niger), R. Peou (Consultant, Cambodia), S. Raihan (ActionAid, Bangladesh), H. Singh (ActionAid, India), A. Tauqueer-Sheikh (CDKN, Pakistan), G. Ziervogel (University of Cape Town, South Africa).

principles necessarily interact and influence each other, there is an increasing risk of maladaptation from initiatives encompassing these eleven principles to initiatives meeting almost none of them.

These principles had been identified base upon fieldwork done in Mauritius Island for the International Organisation for Migration (Gemenne and Magnan 2010, Magnan 2012), and upon an extensive state-of-the-art of the literature dealing with the implementation of adaptation (e.g., Ebi *et al.* 2004, de França Doria *et al.* 2009, Berrang-Ford 2011) and with the identification of concrete adaptation options (e.g., on “robust” and “no regret” options – Lempert and Schlesinger 2000, Lempert and Collins 2007, Hallegatte 2009, Heltberg *et al.* 2009).

Table 1: 11 guiding principles to avoid maladaptation to climate change

Avoid environmental maladaptation

- (1) *Avoid degradation that causes negative effects in situ*
- (2) *Avoid displacing pressures onto other environments (neighbouring areas or areas that are connected ecologically or socio-economically)*
- (3) *Support the protective role of ecosystems against current and future climate-related hazards*
- (4) *Integrate uncertainties concerning climate change impacts and the reaction of ecosystems*
- (5) *Set the primary purpose as being to promote adaptation to climate-related changes rather than reduce greenhouse gas emissions*

Avoid sociocultural maladaptation

- (6) *Integrate local social characteristics and cultural values about risk and the environmental dynamics*
- (7) *Integrate and develop local skills and knowledge related to climate-related hazards and the environment*
- (8) *Call on new skills that the community is capable to acquire*

Avoid economic maladaptation

- (9) *Promote the reduction of socio-economic inequalities*
 - (10) *Support the relative diversification of economic and/or subsistence activities*
 - (11) *Integrate any potential changes in economic and subsistence activities resulting from climate change*
-

These guiding principles apply to the different forms of adaptation implementation (policies, plans, projects). They are not intended to enable an *ex post* evaluation of the benefits and shortcomings of measures undertaken in the name of adaptation, but rather to inform the formulation of adaptation policies, plans and projects prior to their implementation (*ex ante* approach).

3.1. AVOID ENVIRONMENTAL MALADAPTATION

A good part of the leeway available to socio-ecological systems for addressing the natural or anthropogenic disruptions that destabilise economic and subsistence activities depends on existing environmental balances (Ostrom 2009). Thus, a core objective is firstly to avoid damaging the environment not only on the socio-ecological system on which the initiative is implemented but also on neighbouring or distant socio-ecological systems. An adaptation initiative that simply shifts environmental pressures elsewhere is considered here as maladaptation in that the components of vulnerability are relocated rather than reduced. To constitute an adaptation, an initiative must necessarily be consistent with the nature and dynamics of existing environmental components, and must take into account the potential threats of climate change on evolving environmental conditions (e.g., direct and indirect impacts on resources). Five guiding principles support this objective:

(1) *Avoid degradation that causes negative effects in situ*, i.e. the socio-ecological system in which the initiative is implemented (direct environment). An ideal initiative would of course have an attenuating effect or, at the very least, no collateral effect on assets' exposure to climate-related hazards, overexploitation of resources, habitat degradation or pollution of ecosystems. This is not always possible on the ground, as it is often necessary to make trade-offs between development challenges and environmental challenges (e.g., when a large coastal city has to be protected). In this case, the initiative may only be considered as "adaptation" if it takes its own *in situ* negative effects into account and if, in parallel, it puts in place compensation mechanisms.

(2) *Avoid displacing pressures onto other socio-ecological system (neighbouring systems or systems that are connected ecologically and/or socio-economically)*. Since the initial aim of any adaptation process is to reduce pressures on the environment and not to displace them, implementing an initiative on a given socio-ecological system should not, in an ideal scenario, lead to increased pressures on the environment elsewhere. One must be aware, however, that here again it is not always possible to avoid such displacement of pressures, which means that it is also crucial to take this constraint into account and engage in parallel compensation mechanisms.

(3) *Support the protective role of ecosystems against current and future climate-related hazards*, so as to maintain natural buffer zones in face of the impacts of both sudden events (e.g., storms, floods) and gradual changes (e.g., sea level rise). A classic example is the maintenance of coastal dunes that act as a buffer against storm surges when in good condition (continuity of the dune belt and presence of dune-binding vegetation).

(4) *Integrate uncertainties concerning climate change impacts and the reaction of ecosystems*, so as to maintain enough leeway to adjust activities in the event of environmental changes and new scientific knowledge. The concept of flexibility is considered here as a mainstay of adaptive capacity (Adger *et al.* 2005, Cardona *et al.* 2012).

(5) *Set the primary purpose as being to promote adaptation to climate-related changes rather than reduce greenhouse gas emissions*. If the initiative can help to reduce greenhouse gas emissions, it must above all focus on resilience and the alleviation of vulnerability to natural hazards (both sudden and gradual). This principle aims to avoid the confusion – still very common in the field – between adaptation and mitigation.

3.2. AVOID SOCIOCULTURAL MALADAPTATION

The leeway open to socio-ecological systems facing natural or anthropogenic disturbances will also depend on human characteristics, here the ones related to the environment (beliefs, risk perceptions, traditional uses of natural resources, etc.). Adaptation initiatives must therefore be consistent with the social characteristics and cultural values of the community concerned, and based on local capacities and knowledge in the field of environment and natural hazards (Adger *et al.* 2005, Adger *et al.* 2009). First of all, this means avoiding upsetting the sociocultural equilibrium by developing skills at community level and, at the same time, generating or maintaining collective responses. Three main guiding principles apply here:

(6) *Integrate local social characteristics and cultural values about risk and the environmental dynamics*. Initiatives must take into account the expectations of the community in terms of material and immaterial living conditions, both in the present and the future, as these expectations are key drivers of the increase in risk exposure over time, and more generally of vulnerability to climate variability and change.

(7) *Integrate and develop local skills and knowledge related to climate-related hazards and the environment*, in order to support the involvement of members of the community in and/or around the initiative taken in the name of adaptation to climate change. Such an involvement is indeed decisive

for the success of the initiative (including its long-term benefits), and it often depends on the self-confidence of the community members in their ability to drive the change.

(8) *Call on new skills the community is capable to acquire.* The previous principle does not necessarily imply that the community should be limited to the skills and knowledge it already has; first, because these skills are not always favourable to the environmental balance – and thus have to evolve – and, second, because new needs may emerge from changes in hazards and environmental conditions, and acquiring new knowledge and expertise is an element of adaptation. This principle also raises the importance of enhancing people’s self-confidence in their ability to drive the change.

3.3. AVOID ECONOMIC MALADAPTATION

This is usually the dimension that is most readily apprehended by analytical works on adaptation initiatives (see for example Barr *et al.* 2010). In short, the overall idea is to prevent the initiative from creating poverty, on the one hand, or investment irreversibility, on the other (investments put to use at a given time but which can no longer be used at a later date). Three guiding principles are:

(9) *Promote the reduction of socio-economic inequalities,* as they indirectly affect the exploitation of natural resources (Billé *et al.* 2012) and stimulate settlements in marginalized and hazard-prone areas (e.g. in atoll countries: Spennemann 1996, Yamano *et al.* 2007, Duvat *et al.* 2013), and consequently exacerbate vulnerability. Ideally, an initiative must ensure that the present income that various groups derive from economic and/or subsistence activities does not decrease and, at best, it should provide a new source of income. However, one key fact must not be ignored: in the vast majority of situations, there will almost inevitably be “winners and losers” (because environmental degradation affect existing economic activities, or because an extreme event occurs, or because new activities are developed). In other words, the redeployment or development of activities is not equally beneficial to all of the groups concerned. Recognising this reality is a prerequisite for an initiative’s sustainability and thus its relevance in terms of adaptation to climate change. Reducing this winner/loser gap or, at the very least, not widening it is thus a critical issue.

(10) *Support the relative diversification of economic and/or subsistence activities.* By avoiding a situation where all activities are threatened by the same climate-related hazards, diversification enables the community to acquire or maintain a certain leeway in the event of both sudden and gradual environmental disturbances that, together with climate change, will affect various natural resources and means of production.

(11) *Integrate any potential changes in economic and subsistence activities resulting from climate change:* avoid developing activities that require heavy investment (money, time and energy) but which will quickly become obsolete due to climate change (Hallegatte 2009).

4. CONCLUSION

This paper argues that *ex ante* analysis of adaptation initiatives is just as important as *ex post* evaluation. While the latter provides monitoring of the effectiveness of implementing adaptation and using dedicated funds, *ex ante* analysis also plays a part in improving adaptation efforts, mainly because it helps to avoid maladaptation. To this end, 11 guiding principles are proposed. They lead to the conclusion that one of the major challenges of implementing adaptation entails “starting by doing well what we do badly”.

This approach carries very positive news for decision-makers and practitioners in charge of implementing adaptation on the ground. In fact, avoiding maladaptation is largely based on not repeating past and present mistakes (e.g., in spatial planning and managing natural hazards), in line with the “First, do no harm” principle developed for the late 19th century in the medical field (Smith 2005). This means that these actors already have empirical experience on the basis of which they can

begin to adapt and, thus, already have the means to partially overcome the problem of uncertainty on the impacts of climate change.

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KEY MESSAGES

1. **The UK has an under-reported wildfire problem;** an improved evidence base is needed.
2. **Wildfire risk and its causes vary over the UK;** Wildfires are started by humans , accidentally by recreational visitors, transport and escaped managed fires, and maliciously by arsonists. We need to know more about the UK fire regime (date, intensity, duration, size and location and type of vegetation fires) – and how this is changing.
3. **Managed fires and wildfires are linked,** together determining fire regime. Managed fires can reduce wildfire risk by controlling fuel load, but escaped fires can become wildfires.
4. **The impact of fire on ecosystem services is contested.** It varies with fire regime. Severe wildfire should be recognised as an ecosystem disservice, especially in peatlands. Cross-sector cooperation is required to avoid well-intentioned management unwittingly increasing wildfire risk.
5. **Fires are costly to put out, and have long-term cost implications for ecosystem services.** Treating ecosystem services as property assets would allow the costs of suppressing wildfires to be set against the avoided costs of damage to these services.
6. **There are three main challenges to future management** of wildfire risk on moorlands and heaths ; land and recreation management and the effects of climate change.
7. **Wildfire management needs combined strategies** of fire suppression, prevention and protection of ecosystem services, including fuel and risk reduction.
8. **Specialist equipment, training, models and forecasting tools** are needed.
9. **Research and knowledge exchange** on wildfire need to be supported.
10. **Partnership working is an effective and efficient approach** to address the wildfire problem.



Figure 1: Wildfires on the UK, 18 April 2003. Red dots mark the location of active fires detected by the MODIS satellite. Smoke plumes from large moorland fires can be seen. (NASA/University of Maryland¹)

FIRES Seminar Series

The FIRES seminar series discussed the key but equivocal role of prescribed fire and wildfire, and the many controversies for management and policy making. Four seminars were held in 2008/9 on the effects of moorland and heathland fires on ecosystem services in the UK. The series was funded jointly by ESRC and NERC as part of their transdisciplinary series on ecosystem services. Other sponsors included Scottish Natural Heritage, Game and Wildlife Conservation Trust, and the Peak District National Park Authority. Over 130 different people attended; the majority were practitioners. Demand exceeded ESRC/NERC funded places by over 70%.

The environmental, social and cultural ecosystem services provided by moorlands and heathlands include carbon capture and storage (especially on peatland), biodiversity, water provision, flood protection, aesthetic/recreational value, and economic value from tourism, sporting enterprises, forestry and grazing. Fire is historically important in shaping moorland and heathland landscapes. Managed rotational burning is used to maintain heather moors for grouse and grazing animals. Its effect on ecosystem services is contested. Wildfire is accidental or malicious vegetation fire. Severe wildfire increasingly threatens ecosystem services.

This document expands on the key messages from the series, makes policy recommendations and identifies knowledge gaps.

1. An under-reported problem: poor evidence base

Wildfire is a significant semi-natural hazard in the UK. Wildfires occur every year in the UK (Fig. 2), with 71,700 'vegetation fires' of all sizes and types recorded on average between 1974 and 2005². Severe fires can occur in any year, but mainly in drought years such as 1995 and 2003. Yet UK reporting of vegetation fires is poor at national, European and UN level.

The evidence base for vegetation fires is poor because: (i) most vegetation fires do not damage property or cost lives, so, until recently, they have been reported to a lower standard than structural fires; (ii) data collection is not standardised between the 41 regional Fire and Rescue Services (FRS). For moorland fires, we know where the FRS tenders parked, but usually not where the fire actually occurred. Nor do we know the severity of vegetation fires or their confirmed cause. Reporting aggregates types of vegetation fires. From April 2009, the UK-wide Incident Recording System (IRS) should improve reporting. It is being locally implemented, so common core data urgently need to be identified.

2. Regional variations in fire regime and cause

Fire regime is the frequency, timing and severity of vegetation fires, including prescribed burns and wildfires. Fire regime varies regionally, but work is needed to describe and define this. Causes of wildfire are also thought to vary regionally. They include escaped prescribed burns, discarded cigarettes and barbecues, sparks from ordnance or trains and arson.

3. The role of land management prescribed burns

Prescribed burns (Fig. 3) can lower wildfire risk by reducing fuel load and creating fire breaks, but can become wildfires if poorly managed. Research is required on their spatial relationship with wildfire over the UK; are prescribed burns associated with fewer or less severe wildfires, or the reverse? Prescribed burns and wildfires need to be considered together in defining UK fire regimes and how they are changing.



Figure 3: Prescribed burns (© Geoff Eyre)

4. An ecosystem disservice?

The impact of fire on biodiversity, carbon budget and water colour is controversial. It can be both positive or negative, depending, for instance, on fire regime. Yet most research relates to single fires. New work is needed on UK fire regimes and their impact on ecosystem services. Ecological impact also depends on the baseline, time scale over which recovery is measured, and management objectives. We need to know the optimum fire regimes to manage different ecosystem services, and how to prioritise between them. In managing ecosystem services, unwanted knock-on effects of an increased risk of severe wildfires must be avoided, and synergies maximised.

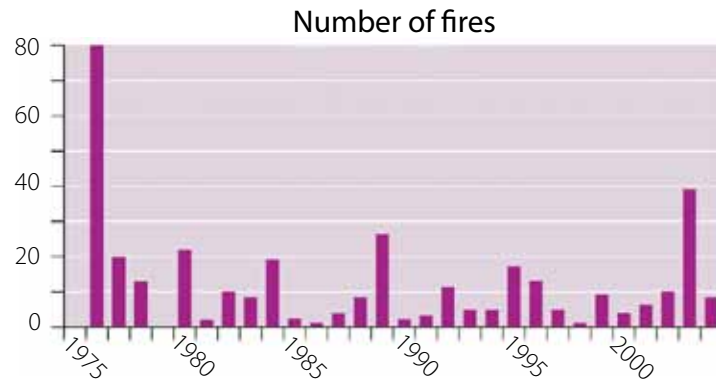


Figure 2: Wildfire frequency in the Peak District National Park, 1975 to 2004 (based on Peak District National Park Rangers' fire log)

POLICY RECOMMENDATIONS

- 1. A nationally-consistent wildfire evidence base;** UK-wide standard for reporting vegetation fires within IRS, notably geo-location of the fire ground, and links to other fire databases, such as those utilised by the EU.
- 2. Cross-sector wildfire risk assessment;** wildfire hazard management should be recognised on Defra's checklist of ecosystem services³, and included in risk assessment of land management plans.
- 3. Recognition of the economic and social value of all ecosystem services;** calculate avoided costs of damage to ecosystem services to be set against direct costs of wildfire prevention and suppression.
- 4. A combined wildfire strategy;** prevention and suppression alongside risk reduction and fuel reduction, including a review of current burning restrictions.

5. Economic costs of fires

Fires are costly and challenge the resilience of FRS to tackle other incidents. One Peak District fire in 2006 took 31 days and a helicopter to suppress at a total cost of around £1million. Helicopters are expensive - but effective if called out early. Long-term implications include loss of ecosystem services and cost of landscape restoration after damage – £2m for one moor in the Peak District since 2003. Prevention and suppression costs need to be set against the cost of avoided damage to ecosystem services. This will require treating ecosystem services as property assets in the same way as buildings.

6. Three linked challenges

Climate is changing and will affect wildfire risk (Fig. 4). Its effects are complex, but are expected to mean more summer droughts with more frequent severe wildfires, like those of 2003, and a later fire season. Warmer, wetter winters are likely to bring increased fuel accumulation and fewer suitable days for prescribed burns. Warmer summers are likely to increase visitor numbers and ignition sources. This will bring further challenges for public access, which is already restricted on Access Land at times of high fire risk. These effects must be considered alongside changes in land management and rural policy. Any policy change which results in increased fuel load or increased public access potentially increases wildfire risk.

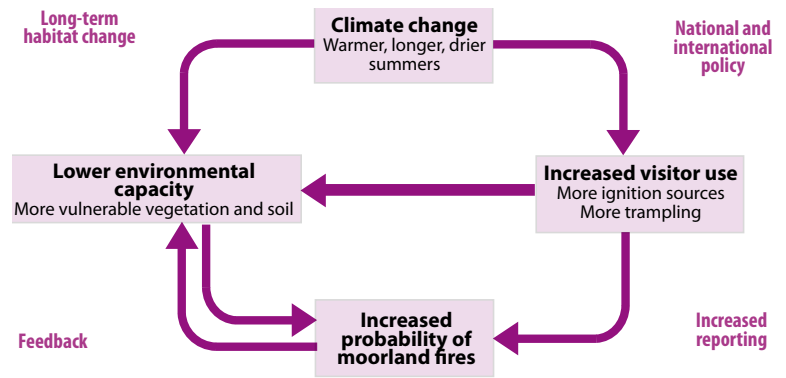


Figure 4: Relationship between wildfire, climate change and people

7. Combined wildfire management strategies

Management of wildfire risk requires a combination of: fuel load reduction; reducing risk of ignition from human sources; reducing the flammability of vegetation in dry conditions; and improving suppression. Over-suppression without other measures increases the risk of severe fires, as has occurred in the USA. Fuel load management is critical. There is a need to review policies which inhibit fuel load management. Land managers say that current UK land management policy is allowing fuel loads to become dangerously high; evidence is needed.

8. Equipment, training and technical tools

Most FRS are neither well equipped nor well trained to deal with vegetation fires. Research and knowledge exchange on UK fire behaviour, especially for peat fires, is needed to improve the efficiency of fire suppression. Tools for forecasting and modelling wildfire risk in UK conditions are required, ranging from fire risk maps based on past fires (Fig. 6) to an improved fire danger rating system and fire behaviour models for UK conditions.

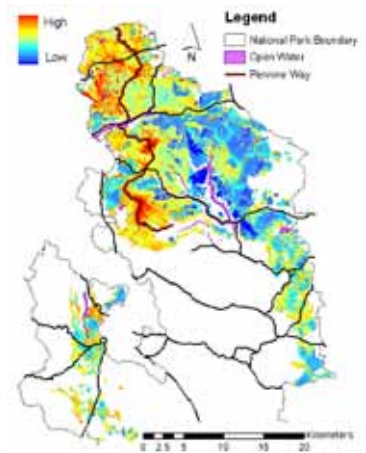


Figure 6: Risk of wildfire occurrence in the Peak District National Park, based on 30 years of wildfire records⁴

9. Research and knowledge exchange

FIRES showed the value of knowledge exchange. New research is also needed. Knowledge gaps are identified overleaf.

10. Partnership working

Partnership working in Local Fire Groups, such as the Fire Operations Group (FOG) in the Peak District National Park, is an efficient and effective 'grass-roots' approach to the wildfire issue. FOG's activities include cross-sector, cross-FRS brigade incident planning, and compatible suppression equipment and techniques. This approach should be supported by central government. It is helpful both in planning, preventing (Fig. 7) and responding after a fire.



Figure 7: Warning signs at a popular access point in the Peak District National Park

5. Support for partnership working in Local Fire Groups including:

- A national funding framework for delivering a wildfire strategy, for instance, via the Scottish and English Wildfire Forums;
- Regional or local level coordination by Local Fire Groups to share best practice in training, equipment sharing, burn plans, etc;
- Participation of the research community; and,
- Capacity building, retention of expertise and delivering training at the national level.

6. Funding of research to address the knowledge gaps, as identified overleaf.

7. Regular, frequent monitoring and policy review, for instance by the English Wildfire Forum and Scottish Wildfire Forum.



Figure 5: Fire and Rescue Services attending a moorland fire at Harbottle, Northumberland, 7 April 2007 (© Steve Miller)

KNOWLEDGE GAPS

- 1. A comprehensive, accurate, spatially robust and accessible evidence base on UK wildfires:** What core data should all FRS collect on attended vegetation fires within IRS? How can we best combine this with fire databases kept by land owners? Could remotely sensed data usefully contribute?
- 2. Acceptable multi-disciplinary criteria for assessing and measuring fire severity:** How should fire impacts on biodiversity, water quality, scheduled ancient monuments, carbon budgets, etc. be assessed? What proportion of prescribed burn and wildfire burn scars show signs of severe burning; i.e. are prescribed burns always mild burns and are all wildfires always severe burns?
- 3. Changing regional fire regimes:** What is the relationship between frequency, severity and timing of prescribed burning to that of wildfires? Are prescribed burns associated with fewer and less severe wildfires, or with more frequent and severe wildfires? Does this vary over the UK? How are changes in land use and grazing intensity, etc. affecting fuel load and wildfire?
- 4. Appropriate fire regimes:** What fire regimes are needed to achieve management objectives for each ecosystem service under climate change scenarios?
- 5. Synergy and conflict between policies:** To what extent do policies for managing single ecosystem services conflict with or reinforce policies for managing wildfire? How can we manage this interaction?
- 6. Appropriate costing tools for ecosystem services:** especially for non-use regulating and cultural ecosystem services: Using these tools, what are the indirect costs of a vegetation fire on ecosystem services relative to the direct costs of fire-fighting and active fire prevention?
- 7. Stakeholders' attitudes to wildfire:** Are attitudes changing in response to climate change scenarios and changes in the rural economy? What evidence is there that climate change actually increases visitor pressure and the incidence of fire? What is the best way of minimising arson and accidental fires?
- 8. Improved technical tools for UK conditions:** including a better UK-wide fire danger rating system, especially one which can be used to guide timing of prescribed burns; fire behaviour models suited to UK and peat fires; spatial fire risk mapping based on historic data.
- 9. Knowledge exchange and research partnerships with fire managers:** Topics include vegetation fire behaviour, tactics for fighting wildfires (including use of suppression fire), use of geospatial technologies such as GPS and visualisation, and knowledge required to complete compulsory key data fields in IRS.

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Figure 8: Experimental gorse fire (© Colin Legg)

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Royal Society Consultation on Human Resilience to Climate Change and Disasters

This response addresses the following question raised in this consultation:

Who are the real adaptation decision-makers / where are adaptation decisions really made?

According to the United Nations International Strategy on Disaster Risk Reduction (UNISDR) terminology¹ adaptation is defined as the *'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'*. UNISDR adds the following comment: that this definition addresses the concerns of climate change and is sourced from the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). The definition provides the broader concept of adaptation which also applies to non-climatic factors such as soil erosion or surface subsidence. It acknowledges that adaptation can occur in autonomous fashion, for example through market changes. It can also occur as a result of intentional adaptation policies and plans. Finally UNISDR states that many disaster risk reduction measures can directly contribute to better adaptation.

In the Hyogo Framework for Action 2005-2015 (HFA): Building the Resilience of Nations and Communities to Disasters 2005-2015, the call was made to *'promote the integration of risk reduction associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change, which would include the clear identification of climate related disaster risks, the design of specific risk reduction measures and an improved and routine use of climate risk information by planners, engineers and other decision-makers'*² It also called to *'promote the integration of risk reduction associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change... are fully taken into account in disaster risk reduction programmes'*. From a global aspect HFA has proved to be a powerful facilitator of disaster risk reduction and has led to close collaboration with other UN based organisations, such as the scientifically focused Intergovernmental Panel on Climate Change, and for policy via the call for each country to have its own National Platform for Disaster Risk Reduction.³

The Chair's summary at the biannual Global Platform May 2013, review of disaster risk reduction by UNISDR called for dynamic, comparable and multidimensional risk assessment methodologies to enable science-based decision-making and identification of development opportunities. This meeting brought together over 3,500 participants from 172 countries with representation from: national and local governments, inter-governmental organizations, Red Cross and Red Crescent, nongovernment organizations, mayors and parliamentarians, representatives of local communities, indigenous peoples, children and youth, persons with disabilities, and leaders from business, academia and science.

The Chair's summary also stated that "organizations [policy makers] increasingly seek systematic evidence based methods for risk-informed decision-making, drawing on scientific analysis and tested indigenous knowledge. All parties need access to risk information and scientific and technical methods that are understandable and usable". The summary went on to add that "participants also called for action to narrow gaps between the scientific community and organisation [policy makers] responsible for implementing disaster risk reduction through the development of collaborative means and methodologies. Initiatives such as the Global Framework for Climate Services play an important role in ensuring development and availability of sector-relevant climate services to support decision-making." Finally it was stated that "it is expected that the HFA2 will recognize the need to govern disaster risk reduction and resilience through clear responsibilities, strong coordination, enabled local action, appropriate financial instruments and a clear recognition of a central role for science."⁴

The IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) ⁵ identified the need for closer integration of disaster risk management and climate change adaptation, along with the incorporation of both into local, sub-national, national, and international development policies and practices. Such work could provide benefits at all levels.

The IPCC SREX report noted the need to address social welfare, quality of life, infrastructure, and livelihoods, and include these factors in a multi-hazards approach to planning and action for disasters in the short term and adaptation to climate extremes in the longer term. It stated that strategies and policies are more effective when they acknowledge multiple stressors, different prioritized values, and competing policy goals.

An iterative process of monitoring, research, evaluation, learning, and innovation can reduce disaster risk and promote adaptive management in the context of climate extremes. Adaptation efforts benefit from iterative risk management strategies because of the complexity, uncertainties, and long time frame associated with climate and climate change. Knowledge gaps need to be addressed by enhanced observation and research to reduce uncertainty and help in designing effective adaptation and risk management strategies.

In the Foresight report on Reducing Risks Of Future Disasters: Priorities For Decision Makers it was noted that the important drivers of change could substantially increase future risks of disasters. These drivers include, but are not limited to the increasing frequency of extreme weather events due to climate change, and large population increases in cities exposed to natural hazards. Choosing to deploy resources to reduce these risks presents significant challenges for policy makers.⁶

In answer to the question “who are the real adaptation decision-makers / where are adaptation decisions really made?”, adaptation is a process that can happen in a wide variety of ways across a wide range of settings. It can be considered at all levels from the individual through local community to national and international. Adaptation does not happen through simple linear decision making but is the result of a variety of interactions and actions, some of which may not be rational decisions but rather driven by more rapid instinctive behavioral processes. Decision makers may be easier to identify for large scale investment in adaptation infrastructure because decision making processes for big decisions are often more formal and more explicit. Key decision makers may include:

- Political and institutional leadership – politicians / chief executives
- Institutional budget holders – treasurer / finance officers
- Those responsible for approval in relation to regulation – planning officials
- Those responsible for developing proposals for investment
- Those responsible for collating and communicating institutional or local risks
- Citizen / staff engaged as part of decision making

For the UK, the National Adaptation Programme identifies a range of key institutions that make or influence decision making and implementation of climate change adaptation actions.⁷ These include national government departments including those responsible for the environment, climate change and local communities; other government agencies including the Environment Agency and Public Health England; local government / planning authorities; regional climate change partnerships; energy providers and regulators, transport providers, statutory funding bodies, regulators; water providers and regulators; healthcare providers, commissioners, regulators; emergency services; Forestry Commission, large land owners including Crown Estates and Ministry of Defence and conservation organizations; and finally local civil society and each individual.

Response Authors:

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James Smith, Consultant in Public Health Strategy, Public Health England

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 - ⁴ UNISDR. Chair's Summary Fourth Session of the Global Platform for Disaster Risk Reduction, Geneva, 21-23 May 2013 Resilient People, Resilient Planet. Available at http://www.preventionweb.net/files/33306_finalchairsummaryoffourthsessionof.pdf (accessed on 5 November 2013)
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 - ⁶ Foresight Reducing Risks of Future Disasters: Priorities for Decision Makers (2012) Executive Summary. The Government Office for Science, London. Available at <http://www.bis.gov.uk/assets/foresight/docs/reducing-risk-management/12-1289-reducing-risks-of-future-disasters-report.pdf> (accessed on 5 November 2013)
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An Evolving Decision-Making Framework in Adaptation and Human Resilience to Climate Change: Some Evidences from California, US

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The Royal Society

on project entitled

Human Resilience to Climate Change and Disasters

Introduction: Resilience and adaptation to climate change is absolutely necessary due to its catastrophic risks posed to human welfare. However, there are substantial uncertainties of decision-making, notably how to develop an appropriate framework helping policymakers and practitioners to choose and implement appropriate measures. This was not helped by ‘embedded’ nature of public, institutional agents within respective turfs (Ng and Pallis, 2010), while effective resilience to climate change clearly requires collaborative, multi-hierarchical and multi-sectoral inputs (UNCTAD, 2012). Such uncertainties reduce the innovativeness of planning and strategies, thus the effectiveness of human resilience to climate change, and thus a paradigm shift in the decision-making framework is necessary.

This article provides some evidences from California, US, notably how the need to increase human resilience of climate change risks by public utilities and transportation

infrastructures has evolved its current paradigm in the decision-making framework. It aims to offer insight to policymakers and practitioners to identify an appropriate decision-making framework so as to develop quality human resilience and adaptation to climate change. Indeed, planning in the US was traditionally characterized by the so-called ‘urban conversation’ (Fishman, 2000) emphasizing individualism, pluralism, active participation from many (and mainly local) stakeholders, and the skepticism of federal (and state) level planning (Brinkley, 2000), recently strengthened by the neoliberal ideology. Indeed, planning in the US, as exemplified by California, was a spontaneous and negotiated regime, with the top-down hegemony being weak (Young, 1989). However, in planning human resilience and adaptation to climate change, a multi-hierarchical decision-making framework, which hardly existed before, has gradually developed.

Funded by the Kresge Foundation, the **Alliance of Regional Collaborative for Climate Adaptation (ARCCA)** was formed in 2012 consisting of four member regions (not cities) within the Californian state (Los Angeles, the Bay Area, San Diego and Sacramento). It initially started as a Joint Policy Committee (JPC), where the Californian State Assembly (CSA) legislated the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) to collaborate in transportation planning. A formal collaboration failed to flourish, not least due to diversified political agendas and priorities between different agents. However, to fulfill the legislation, they started informal conversation, and worked out well. This prompted the Bay Conservation and Development Commission (BCDC) and the Bay Area Air Quality Management District (BAAQM) to join in in addressing climatic issues, thus laying the foundation for ARCCA. Instead of a public agent with authority, ARCCA is a semi-public organization situated between public agents and private stakeholders. It concentrates on building relationship and friendship, and ultimately legitimacy, by illustrating to agents and stakeholders that they are helpful in developing human resilience to climate change, emphasizing ‘what can be done’. Different member regions would decide on their representatives (e.g., San Diego consisted of representatives from the port of San Diego and the San Diego Foundation; the Bay Area consisted of representatives from the business sector).

The major tasks of ARCCA are multi-fold. First, by getting researchers together to a common work platform, it attempts to develop an information and research system

between different regions, including the most efficient use of limited resources and streamline state and regional adaptation assistance to local governments. By doing so, they can work with the Californian State Government (CSG) more closely, and can establish a more unified voice to CSG. This is welcomed by CSG. Indeed, there were even voices from the Speaker of CSA to develop legislations on climate change adaptation, and it was good to have a unified voice from the regions, rather than different stories, priorities and recommendations from different regions. Hence, second, ARCCA aims to work on ‘common stories’ on adaptation and human resilience to climate change, sharing information on the best practices, lessons learned, and the most innovative and successful strategies. Common stories can be powerful tools against stakeholders who try to shelve the issue before ‘real adaptation needs to be done’. Finally, ARCCA aligns the regions with state agencies. As it stands, it is currently a ‘jumble’ and many climate research programs cannot be implemented effectively because state agents, in many cases, do not treat climatic issues as their mandates (e.g., the Public Interest Energy Research (PIER) project was closed down by CSG’s Energy Commission in 2007, as they did not regard climate as anything related to them). Indeed, when discussing adaptation and resilience to climate change, state agents often highlighted ‘what the state should do’, and did not provide any insight on ‘what regions can do’. Many climatic reports at the state level were, indeed, ‘state reports by state agents’ – typical ‘embeddedness’ of public agents within an institutional system. A semi-public organization, like ARCCA, offers the ideal catalyst to bridge the gap between different institutional hierarchies.

In conclusion, we are reaching a critical juncture in the decision-making framework for human resilience and adaptation to climate change. However, ‘embedded’ public agents, both local and state levels, often found it difficult to tackle the multi-dimensional nature of climate change adaptation and resilience planning, especially given the comparative scarcity of legal standards, precedents and inadequate understanding (especially when compared to mitigation). As evidenced in California, ‘soft’ power, through semi-public organizations like ARCCA, gradually becomes more pivotal in the decision-making framework, encouraging hierarchies and sectors coming together, and pulling the strings. Apart from the state level, such a new decision-making framework also evolves locally, like the *Climate Collaborative San Diego Region* (www.sdclimatecollaborative.org) consisting of eight public agent members, e.g., City of San Diego, County of San Diego, Port of San Diego, San

Diego Gas and Electric, etc. Figure 1 illustrates such a new decision-making framework. A critical issue in the future, though, is how they can achieve legitimacy among key agents and stakeholders. Also, their power structure needs to be evaluated from time to time so that they would not become ‘institutionalized’. As mentioned, some sectors from the CSA discuss about establishing an ‘authority’ in governing such organizations. It would be a disastrous move, as the ‘fluid’ nature would solidify and ‘stuck’ the organization within an embedded institutional system.

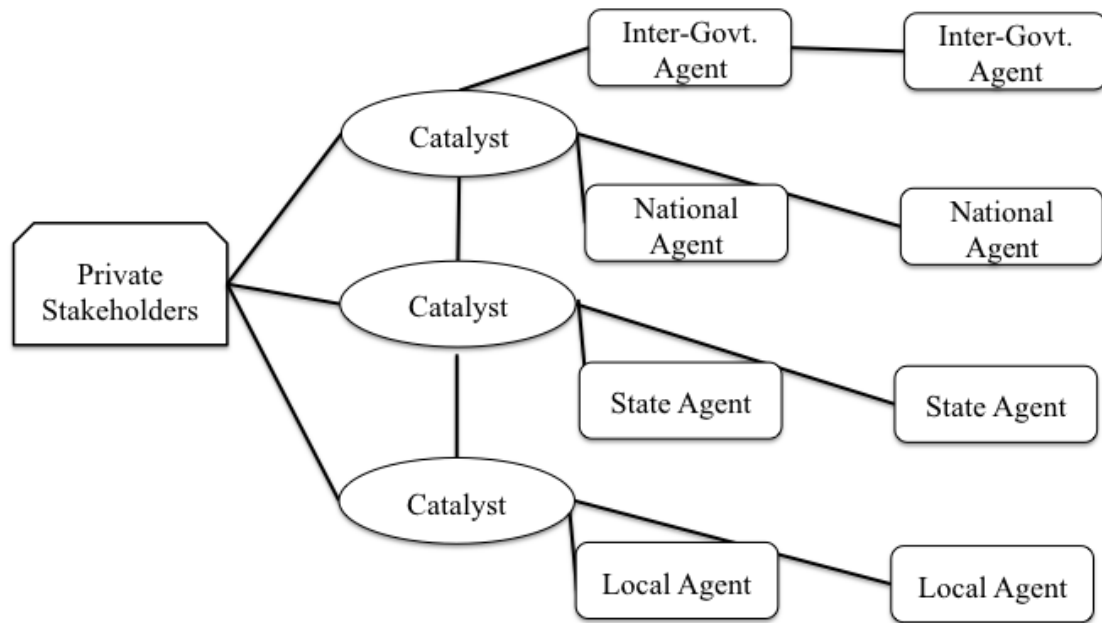


Figure 1. The evolved decision-making framework illustrating the relationship between catalytic organizations, public agents and private stakeholders

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This submission addresses two questions cited in the Royal Society call for submissions, namely:

- (5) What assessment tools and decision making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?
- (10) To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and/or DRR?

One answer to (5) is that community-based cost-benefit analysis is a powerful tool for evaluating resilience-building measures based on farmer adoption of agro-ecological practices and the rehabilitation of degraded lands. Specifically, it provides powerful quantitative and qualitative evidence of both costs and benefits associated with such measures. Where these measures are advantageous, this evidence can deliver a strong business case for supporting – and upscaling – their use. This evidence also provides a basis for comparing such resilience building measures with other competing investment options.

Answers to (10) are provided by two recent reports based on applying this tool to food insecure farming communities in Malawi and Ethiopia. Both reports use community-based cost-benefit analysis to examine the various costs and benefits delivered by longstanding food security projects in small-scale farming communities, then seek to draw wider lessons from these case studies. The report on Malawi was written in 2010 for TearFund¹, while another shorter paper on this work was published by ODI². The report on Ethiopia was written in 2013 for IFRC and will soon be published under the title “Pathways to a Climate Resilient Future: A Community-based Cost Benefit Analysis of the Red Cross Food Security Project in Ambassel, South Wollo, Ethiopia”. A colleague and I are the authors of both reports. If the IFRC document is of interest, I would be happy to provide the full report, though of course I would first need to clear this with IFRC.

The following three paragraphs are from the IFRC report’s executive summary:

“This report summarises an evaluation of the South Wollo Food Security Project, a four-year project by the Ethiopian Red Cross Society (ERCS) that aimed to simultaneously address acute hunger and foster longer-term food security and climate resilience for small-scale farmers in the Ethiopian Highlands. Key questions explored by the study include how well the project delivered on building key aspects of resilience, what benefit-cost ratio it secured, and whether the methodology it applied could usefully be applied more broadly across IFRC projects.

The study found that the ERCS project and government follow up activities were highly successful, as reflected in a benefit-cost ratio of 8.9:1 and improved community resilience. Yet the target communities continue to struggle due largely to emerging threats, notably worsening climate change impacts. Fortunately, the study also found that the work to date by the Red Cross and government left various promising opportunities unexplored, creating hope that seizing these could enable these communities to be fully food secure and resilient to climatic shocks. The report maps out these future pathways, notably by examining farmers’ comments and the insights they provide.

The report concludes that such interventions in food insecure farming communities are invaluable, and deliver benefits that amply justify their costs. Yet these interventions must also learn from past experience in order to maximise their chances of success. Such interventions are especially needed now that climate change impacts pose daunting new threats to small-scale farmers. The methodology employed by the present study provides a useful template for future evaluations to guide future interventions.”

The Royal Society’s call for submissions requested that respondents highlight outstanding knowledge gaps. The key gap in this work is that more such studies using community-based cost-benefit analysis are needed to provide a stronger evidence base and fuller set of data points regarding the potential economic benefits of resilience building measures. Ideally, this should be done for each distinct livelihood context in regions where rural communities are highly vulnerable to climate change, and where ecosystem services provide critical support to local livelihoods. Such studies could help guide efforts to build resilience to both long-standing challenges and emerging threats. Specifically, they could guide potential adjustments in approach – notably greater emphasis on safeguarding and enhancing ecosystem services – given the dramatic new threats to rural livelihoods posed by climate change impacts in recent years.

These future studies could have profound longer-term impacts on target beneficiaries and the agencies that work with them. They could provide a platform for learning from experience and responding progressively to climate change

¹ See http://www.preventionweb.net/files/16866_16866investingincommunities1.pdf#!

² See <http://www.odihpn.org/report.asp?id=3168>

impacts, thus maximising the chances that communities and their partners find viable pathways to the future despite the daunting challenges they face. They could also produce a rich body of evidence on what works where, limits to existing interventions, and needed adjustments to better address emerging risks.

For further details on this work, please contact Jules Siedenburg at jules.siedenburg@linacre.oxon.org or 07981927181.

HUMAN RESILIENCE TO CLIMATE CHANGE AND DISASTERS - ITALY

Italy is still in the process of adopting a National Adaption Strategy to Climate Change.

In September 2013, the Italian Ministry of the Environment has published a “**National Strategy for adaptation to Climate Change**”. The document was drafted taking into account the findings and guidelines included in some relevant documents produced at an international level, including “Adaptation in Europe” (EEA 2013), “Guiding principles for adaptation to Climate Change in Europe” (2010), “Guidelines on developing adaptation strategies” (EC, 2013 a, c, d)” .

The **Mediterranean region** is expected to face particularly negative climate change impacts over the next decades, which, combined with the effects of anthropogenic stress on natural resources and relatively lower adaptive capacity, make this region one of the **most vulnerable areas in Europe**.

In this context, **Italy expects a number of potential climate change impacts and vulnerabilities** including the following:

- **worsening of the existing conditions of high stress on water resources**, leading to a possible **reduction in water availability and quality**, especially in summer in southern regions and small islands;
- **alterations of the hydro-geological regime**, potentially increasing the risk of landslides, flash mud/debris flows, rock falls and flash floods; areas most exposed to hydro-geological risks include the Po River valley with increased flood risk, and the Alpine and Apennine areas with increased flash-flood risk;
- **soil degradation, higher risk of soil erosion and desertification**, with a significant part of the South of the country classified at risk of desertification and specific areas in northern regions showing critical conditions;
- **higher risk of forest fires and droughts over Italian forests**, with the most critical areas being the Alpine zone, southern regions (Calabria, Campania and Puglia) and the insular regions (Sicilia and Sardegna);
- **higher risk of biodiversity and natural ecosystems loss**, especially concerning Alpine areas and mountain ecosystems;
- **higher risk of flooding and erosion of coastal zones**, from increased occurrence of extreme weather events and sea level rise (coupled with both natural and human-induced subsidence);
- **reduction of agriculture productivity** especially for wheat, and also for fruit and vegetables; olive, citrus, vine and durum wheat cultivation could become possible in the North of Italy, whereas corn cultivation could suffer in the South;

Expected effects of climate change on human health in Italy might include:

- increased heat-related mortality and morbidity, associated to summer heat waves;
- slight reduction of cold-related mortality, linked to expected milder winter temperatures (but the extent is not known);
- increased risk of injuries, morbidity (e.g. enteric infections, post traumatic stress disorder and vector-borne diseases) and fatalities, from expected increasing floods, heavy precipitation and fires events;
- increased respiratory diseases and allergic disorders, as a result of the

effects of changes in air pollution

An early **macro-economic assessment of climate change impacts for Italy**, performed by Foundation Eni Enrico Mattei (FEEM) in collaboration with the Institute for Environmental Protection and Research (ISPRA) and the Euro-Mediterranean Center on Climate Change (CMCC), indicates that the country could experience an **aggregated GDP loss of 0.12%-0.16% in the period 2001-2050 equal to a total loss of EUR 20-30 billion, considering a temperature increase of 0.93°C**. Losses could be larger, of about **0.16%-0.20% GDP, for a +1.2°C temperature rise scenario**. In particular, some economic sectors, such as tourism and the economy of the Alpine regions, could experience significant damages. Additionally, more relevant impacts could be expected in the second half of the century, with **GDP losses in 2100 potentially six times larger than those predicted in 2050**. Huge differences in terms of economic impacts of climate change could also emerge between northern and southern Italy.

Italian government is aware that the complex phenomena involved will require a multi-disciplinary approach, with a mix of tools attaining national governance, resilience of prevention, alarm and responsive systems, and training of operators able to develop new methods for the evaluation of risks and vulnerability.

Currently, the Euro-Mediterranean Centre on Climate Change (<http://www.cmcc.it/#>) is undertaking a research project called "**Elements to develop a National Adaptation Strategy to Climate Change**". In the context of the development of National Adaptation Strategies (NAS) across all European countries and a comprehensive European Adaptation Strategy by the European Commission, the Italian approach to develop a NAS involves 3 main elements:

- the collection, analysis and interpretation of sound scientific data on impacts, vulnerability and adaptation relevant per sector at the national level, collected through a working group of national scientists;
- the study of the political process of adaptation at the European level and an investigation about adaptation governance;
- adequate consideration of the results of the involvement of national stakeholders and institutions when allocating priorities for action for adaptation.

Objectives

- Identification of specific sectors for sectorial and inter-sectorial analysis
- Evaluation of the status of scientific knowledge on climate change impacts, availability of data and information at different scales and sectors in the country
- Identification of sectorial vulnerabilities to those impacts and evaluation of related risks
- Support in identifying and analysing current adaptation measures carried out at different scales (national, regional and local) and in various sectors
- Estimation of costs and benefits of possible adaptation measures/actions for various sectors for short (2020-2030) and medium term (2040-2050)
- Support in identifying main national stakeholders and managing dialogue between institution
- Support in elaborating guidelines for sectorial adaptation action at different scales.

This research project will be completed by **31 December 2013**.

Useful contacts: Euro-Mediterranean Centre on Climate change (CMCC)

- **CMCC Scientific leader: Sergio Castellari**

Sergio Castellari, IPCC National Focal Point for Italy, Co-Chair Informal Consultations and Contact Groups at UNFCCC/SBSTA, Italian Delegate in IPCC, UNFCCC, UNCCD, GEO and UNEP, Italian expert EU Working Party on International Environment/Climate Change of EU Council. Involvement in these projects: European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation EEA, CIRCLE-2, CIRCE.

- **CMCC Project manager Climate Services Division: Lorella Reda**

Lorella Reda holds a diploma in business management and foreign languages. She is in charge of project management: Italy-USA Cooperation on Science and Technology of Climate Change; FP6 Integrated Project CIRCE – Climate Change and Impact Research; European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation.



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联合国环境规划署



Division of Early Warning and Assessment Submission to Royal Society Human resilience to climate change and disasters Project

Background

Nearly all efforts to cope with climate change focus on either mitigation for reducing emissions or on adaptation for adjusting to changes in climate. Although, it is imperative to continue with these efforts, the on-going pace of climate change and the slow international response suggests that a third option is becoming increasingly important: To protect populations against the immediate threat and consequences of climate-related extreme events, including heat waves, forest fires, floods and droughts, by providing them with timely, reliable and actionable warnings.

Although great strides have been made in developing climate-related warning systems over the past few years; most of the available systems are characterized by the following shortcomings:

- Most deal only with one aspect of climate-related risks or hazards, e.g. heat waves or drought.
- Most systems do not cover the entire early warning landscape from collection of meteorological data to delivery and response of users.
- Most systems have large gaps in geographic coverage.
- The communication of warnings and outreach to users also needs improvement in most systems, e.g. the timing of issuance of warning.
- Most systems do not incorporate preparedness plans.

UNEP, with the support of the German government, is implementing a project which seeks to find ways to address these deficiencies. The CLIM-WARN project seeks to provide actionable warnings (warnings that can be directly translated by decision makers and citizens into actions for coping with imminent extreme climate events) to the most vulnerable parts of the world.

Results presented here are based on two case studies and preliminary meetings conducted in Kenya and Ghana for the CLIM-WARN project. Full results of the study will be available in early 2015. We have answered questions that were relevant to the CLIM-WARN project. However UNEP is also working extensively on ecosystem-based adaptation.

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1. How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?

The United Nations Environment Programme (UNEP)'s CLIM-WARN project recently held workshops in Ghana and Kenya that brought together various stakeholders in Early Warning¹. Basing on the extensive discussions held, it was agreed that, in Kenya drought is the key hazard, followed by floods, climate related health problems and sea level rise (in coastal areas). Droughts are increasing in frequency, as they currently occur once every 2 years compared to the past record of once every 4 years. Drought affects the following provinces: Eastern, Coast, North Eastern and parts of Rift Valley. The specific districts include Baringo, Laikipia, Turkana, Samburu, Narok and Kajiado in Rift Valley Province, Marsabit and Isiolo in Eastern Province, Mandera, Garissa and Wajir in North Eastern Province and Tana River, Kilifi, Kwale and Taita-taveta in Coast Province.

Floods are experienced in most parts of the country. However some parts experience more severe floods than others including most parts of Kano plains (Nyando district) and Nyatike (Migori district) in Nyanza Province, Budalangi in Western province and the lower parts of Tana River.

Depending on the region, the following events are likely to occur in future;

- Coastal areas - flooding, salinity, salt water intrusion and coastal erosion

¹ In Kenya the following organizations/institutions were represented during the CLIM-WARN workshop; Adaptation to Climate Change and Insurance, Chatham House, Columbia Global Center-Africa, East African Community, Ecommissary Systems, IGAD Climate Prediction and Applications Centre, Institute for Meteorological Training & Research, International Federation of the Red Cross, International Development Research Centre, International Federation of the Red Cross, International Livestock Research Institute, Kenya Marine and Fisheries Research Institute, Kenya Meteorological Department, Kenya Red Cross Society, Lewa Wildlife Conservancy, Ministry of Environment water & Natural Resources, National Disaster Operation Centre, National Drought Management Authority, Northern Rangelands Trust, OXFAM, Regional Centre for Mapping of Resources for Development, Save the Children, SusWatch Kenya, United Nations Strategy for Disaster Reduction, World Meteorological Organization, World Vision Kenya and the Academia.

In Ghana the following organizations/institutions were represented; National Disaster Management Organization, Environmental Protection Agency, Ghana Meteorological Agency, The Institute for Environment and Sanitation Studies (IESS), The Ministry of Gender, Children and Social Protection, The Institute of Statistical, Social and Economic Research, Council for Scientific and Industrial Research, University of Ghana, Vodafone, United Nations Development Programme, Water Resources Commission of Ghana, Ministry of Environment, Science, Technology and Innovation, and the Environment Communicator.

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- Drier areas - likely to see dust and sandstorms and locust invasion
- Islands - Landslide and health related issues
- Lake basin - flooding.

In Ghana, the most frequent hazards are floods, wild fires, droughts and diseases in that order. Floods occur annually especially in Ghana's Northern and Volta regions where more severe floods are expected in future. At present, there are long dry spells with unpredictable rains. Wild fires are mostly frequent during the dry season. Diseases like malaria are influenced by climate. The magnitude and severity is likely to increase in future. A report released by UNICEF-Ghana in May 2013 ranks malaria as the leading cause of death in children in Ghana, accounting for 18 per cent of under-five deaths. The diseases affect all parts of the country.

In summary, discussions in two sub-Saharan countries indicate that stakeholders predict increased intensity of extreme events. It is assumed that hazards will differ across the countries. However, the exact location of such changes are uncertain due to challenges of downscaling models

2. Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

In Kenya, the hazards with greatest impact on people are;

- Droughts: The impact on the Gross Domestic Product (GDP) is very high, for instance, between 2008 and 2011, drought mitigation cost 968 billion Kenya shillings. Drought is also the major cause of death, and can result in famine. For further details please see:
http://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=72
- Floods: They greatly destroy infrastructure; cause deaths of people and animals from drowning and injuries; possible outbreaks of diseases like malaria, cholera, dysentery; contamination of wells and ground water which is the major source of drinking water by most rural communities and loss of harvests and crops in farms.

In Ghana, drought and floods have the greatest impact on people in terms of loss of lives and property. The mortality rate has increased in the past decades due to increased hazards. It is however important to note that there is a variation in timescale of each hazard.

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The vulnerability of people in both countries to the above events may change, either positively or negatively, depending on the adaptation and mitigation strategies put in place, but also on poverty reduction and governance reforms. The poor are often most vulnerable to hazards and have the least ability to respond. Many countries with highest risks and least resilience have weak risk-governance capacities (UNISDR 2008). If these factors are addressed adaptive capacity may increase and vulnerability reduce, despite increases in hazards.

3. *Who are the real adaptation decision-makers / where are adaptation decisions really made?*

The real adaptation decision makers in Ghana and Kenya should be the local governments and the vulnerable communities. Ideally the adaptation decisions will be made at the local level, involving various sectors/group. For instance, disaster risk reduction groups should be created before floods occur, with policy options and emergency funding sources identified. When a flood hits a certain location, local leaders and relevant institutions already have prepared strategies/solutions for the affected areas. Individuals know how to respond as they have been informed and have the means to act.

4. *In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?*

At a later phase the CLIM-WARN project will examine this question further, but the United Nation Framework Convention on Climate Change (UNFCCC) report on “Assessing the costs and benefits of adaptation options” suggests the following criteria:-

- Robustness: this gives an indication of whether the option is robust under a range of future climate projections.
- Effectiveness: This criterion examines which option will meet the objectives.
- Efficiency: It's important to know whether the outputs achieved are optimal in relation to the resources allocated.
- Urgency: The knowledge of how soon the option needs to be implemented is ideal.
- Equity: this criteria informs on whether the adaptation approach will benefit vulnerable groups and communities or not.
- Synergy with other strategic objectives: the approach that offers co-benefits is desirable e.g. proper management of water catchment areas could lead to reduced erosion/siltation and carbon sequestration).



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Программа Организации Объединенных Наций по окружающей среде

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- Flexibility: it is important to know whether the approach will allow for adjustments and incremental implementation depending on the level and degree of climate change.
- Legitimacy: is the option politically, culturally and socially acceptable?

5. *To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?*

UNEP has worked extensively on this question. We suggest contacting UNEP's Division of Environmental Policy Implementation (DEPI):

<http://www.unep.org/climatechange/adaptation/EcosystemBasedAdaptation/tabid/29583/Default.aspx>

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Udyama, India

Questions

1. How will weather-related hazards change in their frequency, intensity and location to a) 2030 and b) 2100?

We are giving local, regional and global perspectives with doable suggestions.

Poverty is ecological in nature in India. The loss of ecological/biological capital leads to poverty. Hence environmental degradation is a major reason for poverty contrary to popular perception that poverty is a big threat to environment. Close to 60 percent of India's population depends on forest based daily livelihoods.

Despite tripling of GDP growth rate in the last two decades, the number of poor remains constant. Poverty is becoming chronic in India, most of the poor have remained below the poverty line, and the impact is so serious that next generation is also likely to remain so. Growth-based economy has definitely assured us a position where India is being rated as one of the fastest growing developing countries of the world. But at the same time, there are close to 300 million poor, the single largest chunk of the world.

Further, land-water-forest with environment and people had its very uniqueness for its cultural and organic bondage. This bondage now is working differently. It is expected that the situation will worsen further in future as close to 50% are BPL lies in general and close to 90% are BPL families in tribal districts of Orissa and this is happening in majority of eight states in India. **Number of poor in 8 Indian states more than in 26 poorest African nations (recent UNDP report -Source: PTI, Jul 12, 2010)**

Unexpected weather event, Uneven rainfall, depleting resource base, continuous crop failure, recurrent water scarcity, malnutrition, squeezed food basket, fragmented ecology followed by high frequency of disasters (Sea storms, cyclones, flash floods; droughts, health hazards) have severely affected majority states and Orissa particular since last few decades.

The two important emergent issues are: accelerated degradation of environmental and natural base consequent and marginalization process continuing unabated. Resilience of and adaptation to vulnerability of livelihoods have been threatened in coastal, rural and urban areas too. The **Environmental costs are increasing manifold and mitigation response is also challenging**. Poverty, hunger, trafficking, foeticides, drinking water, slum growth, sanitation, health-hygiene are very acute.

- **Poverty of environment** (vulnerability adaptation to climate variability, loss of biodiversity, waste management, pollution, poor renewable energy use, natural disasters and industrialization leading to severe environmental degradation)

- **Water poverty** (safe drinking water, water conservation and recycle water , waste water disposal , water contamination, pollution and groundwater receding)

Further, Fear, Risk, Stress, Shocks, Trauma, Worries, Threats, Hazards, Conflicts, Drudgery, Imbalances, Speculations, vulnerabilities are getting accelerated due to recent climate changing chaos.

<http://epaper.hindustantimes.com/>

<http://www.hindustantimes.com/Chronic-hunger-kills-50-in-Orissa-district/H1-Article1-512211.aspx>

- **Chronic hunger kills 50 in Orissa district**

Nine-year-old Ram Prasad Bariha saw his brother, sister and mother die within a month — September 2009. His father, Jhantu Bariha (42), followed a month later.

The dreaded Kalahandi-Balangir-Koraput (KBK) belt of Orissa is yet to come out of the starvation-migration-death cycle. It accounts for 71 per cent of the state's families below poverty line (BPL).

<https://mail.google.com/mail/?shva=1#inbox/12608ef2e0b8ca8c>Orissa to reduce

- **High malaria mortality rate**

The malaria mortality rate came down to 15 per cent till July 2009. But the mortality rate is still high, as about 239 died last year. We are aiming to reduce the mortality in the next five years," Health and Family Welfare Minister of Orissa Prasanna Acharya said.

- **High mortality rate worries govt**

<http://timesofindia.indiatimes.com/city/bhubaneswar/High-mortality->

The state has witnessed a fall in birth rate between 2002 and 2008. At the same time, the infant mortality rate (IMR) has gone up. According to the Population Foundation of India (PFI), crude birth rate has come down from 23.2 in 2002 to 21.4 in 2008, while the state has second highest IMR in the country with 69 per 1,000 live births.

Living with Environmental Change: Our planet faces unprecedented change. If we continue on our current path, by the end of this century, or earlier, our environment will be in a state that modern humans have never experienced. In parts of the world, supplies of food and water will be at risk and flood defences stretched

Even after the passage of 62 years of independence, people continue to struggle with the problems of deprivation and powerlessness. The extremity of the degree and implications of poverty is experienced by the situation that forces the people to live within a constant state of impoverishment, in circumstances where their most basic human rights, entitlements are need to rethink.

The intensity and frequency of droughts and floods appear to be increasing every year with declining vegetation and ground water availability followed by increasing of flash floods. There is media reporting that these regions are *slowly moving towards desertification*. . Thus, under the changing climatic situation (arising as a result of natural phenomena and or outcomes of human made developments), the relationship between ecology and sustenance has been badly affected

“Perpetual hunger, perennial drought ,uneven rainfall, climatic variability, continuous crop failure, malnutrition, depletion of natural resource base, squeezed food basket, skewed land distribution, inadequate institutional linkages and infrastructure, inadequate bargaining power etc. count amongst the primary concerns of western/tribal districts in particular and Odisha in general. ” Risk and vulnerability is getting compounded due to devastating natural, social, physical, economical and environmental capital, combined with poor political representation followed by nutritional and health hazards causing to disrupting the livelihoods that causes distress migration, child sale and women trafficking with rampant social, mental and physical abuse

- **HDI Failed in Odisha:**

<http://www.expressbuzz.com/edition/searchresult.aspx?AliasName=LGvEiZyRiiyPaylP3jQooVmbBdf6glQA>

Providing proper atmosphere to ensure decent living of the citizens, access to knowledge, health, food and nutritional security are benchmarks for sound Human Development Index (HDI) ratings of a State.

2. Which weather-related hazards have the largest impacts on people? How is the exposure and vulnerability of people to such events likely to change from now until 2030?

Reality realization:

91% disasters in 2009 due to weather **Half of these disasters — mainly storms and floods — have taken place in Asia, a UN study says**<http://igovernment.in/site/91-disasters-2009-due-weather-36305>

Climate change disproportionately affects those living in extreme poverty. Further undermining their ability to live their lives in dignity, rising sea level, increasing ocean and surface temperature and extreme weather events like storms, droughts and cyclones are felt most acutely in poorest countries of the world and amongst the poorest and most marginalized.

People living in poverty are less able to prepare for, or adapt to, climate change effects on the associability and availability of food, drinking water, sanitation adequate housing and health care. A growing number of people will face

disproportionate and loss of their homes and livelihoods which may also result in increased social unrest.

Time We Take Climate Change Seriously

Many communities already feel the adverse effects of warming temperatures – yet so far few remedies are available. Climate change already threatens the livelihoods of peoples in distant corners of the world, from North Alaska to the Pacific islands. It is contributing to rising prices for grains and staples that are undermining food security for millions, particularly in countries with unstable weather patterns. It poses a profound threat to development in states that currently lack the resources to fulfil basic human rights. The scope of these problems – and of the action required to treat – reach beyond previous human challenges. Climate change shows up countless weaknesses in our current institutional architecture, including its human rights mechanisms.

Fundamental human rights and freedoms are described in the Universal Declaration of Human Rights as “freedom from fear and want” has been proclaimed as the highest aspiration of the common people, (<http://www.un.org/en/documents/udhr/>) The declaration further proclaims that every one as a member of society.. is entitled to realization, through national and international cooperation and in accordance with the organizations and resources of each state, of the economic and social and cultural rights indispensable for dignity and free development of personality. Human Rights standards offer a valuable perspective with which to understand the impacts of climate change on the world’s most vulnerable people. And this has clarified the obligations of states both collectively and individually, to minimize that results from climate change and help vulnerable people and community adapt to its inevitable effects. Office of High commissioner for Human Rights has established that “looking at climate change vulnerability and adaptive capacity in human rights terms, highlights the importance of analyzing power relationships addressing underlying causes of inequality, discrimination and gives particular attention to marginalized and vulnerable communities of societies especially people living in poverty, climatic variances, livelihoods resilience.

Vulnerability the degree to which people are susceptible to the adverse impacts of climate change i.e level of resilience and capacity to cope of community. Persons living in a developing country faced 79 times greater risks of being affected by climate induced disaster .262 million people affected by climate disasters annually from 2000 to2004 over 98 percent were living in the developing world. The uniting theme for the International Day for the Eradication poverty. Almost 50% of the population in the sub-Saharan region of Africa lives on under \$1 a day.In Nicaragua, 45.1% of the population lives on less than \$1 a day.

In India, the number of people living under \$1.25 a day increased from 421 million in 1981 to 456 million in 2005.

Climate change modeling and India

One of the most accepted climate change models is that if global warming will continue USA will be drier, India will be wetter, and Europe will be warmer. Regarding Indian subcontinent, the forecast is that there will be more destructive sea storms, sea surges, coastal erosion and coastal inundation. Even if serious efforts are now made to reduce green house gases, the effect of such gases already released to atmosphere will continue be felt for decades to come, because of long residence time of these gases in atmosphere.

Another apprehension is that global temperature may not rise in a linear manner; there may be sudden and stiff rise in temperature. That is to say that the temperature curves instead of being linear it can be kinked

Climate change – Orissa context

Rich state like Orissa unfortunately is in the path way of depressions and cyclones formed in the Bay of Bengal during south west monsoon. With advance in global warming if sea storms acquire greater destructive power as is being forecast, the state will be required to bear the brunt of such storms which means all the gains of development will be washed away in flood/storms waters. Even in a year floods and droughts have witnessed.

<http://www.responsenet.org/show.detail.asp?id=22709>

There are huge gaps in practice, policy, program followed by reflection & research to know the reality and find the way out for mitigation or adaptation strategies.

Despite there are severe threats of floods cyclones, coastal erosion, inundation, heat wave, flash floods, distress migration and hunger, enormous opportunity are there to regenerate revive, and rejuvenate the fragmented livelihoods through consorted actions and initiatives with regard to human adaptation and regional resilience capability

Therefore Research needs:

- Study of coastal dynamics and sea current changes (wind velocity etc.)
- selection of species which can withstand high velocity storms of creating coastal shelter belts
- Nature of protection walls/ dykes, housing and other infrastructure

Manifold Disasters and accelerating vulnerabilities (Floods, Droughts, Sea Surge, Coastal Inundation, Cyclones and Heat waves): What Next?

“If ever concept called disaster tourism is to catch fancy of those bitten by wander bug, then Orissa certainly will be the number one destination. Floods droughts, cyclones and heat waves, this eastern state has it all.

Floods have been a regular affair of every monsoon for the past 18 years. The other extreme, droughts have been going side by side for last 19 years. Cyclones have dealt heavy blows to the people for the last seven years. These natural disasters have killed many including innumerable number of livestock and destroyed property. According to the state government’s Human Development Report 2004, property loss has been steadily growing every year over the past few decades.

“Natural calamities have become a serious problem for the poor people of Orissa. It has increased vulnerability and has caused serious fiscal imbalances through a heavy demand on revenue on expenditure, expenditure on restoring assets and reduction of revenue in terms of taxes and duties because of crop and property loss”.

We are witnessing coastal inundation in many places and there is no country wide or widespread drought in the past several years. The drought situation has become localized. Higher rainfall may mean higher food production but gains of higher food production will be neutralized by greater incidence of diseases. There is already resurgence of malaria and other water borne diseases

Floods

Before draining into the Bay of Bengal, all the major rivers of **Orissa** flow long distances; some of them having their sources originating beyond the state of **Orissa**.

The intensity of floods inundating the rivers depend much on the topography of the State, the drainage system with low channel capacity, low flood slope, sand banked mouths, high concentration of rainfall in a small number of days in the catchments basin etc. The frequency of such floods during the last one and half century (1968-2004) is presented below.

- Between 1868-1967, i.e. during a span of hundred years, there were 262 flood inundations
- in the state, of which 68 were high floods. 77 of them were medium floods and 117 low floods.
- Among the rivers Mahanadi experienced the highest number of floods i.e 99 times.

- In other major rivers of **Orissa**, Brahmani experienced such floods 77 times whereas Baitarani caused floods for the 86th time. However, the scale of grimness of the floods of 1881, 1894, 1896, 1907, 1920, 1926, 1927, 1934, 1940, 1941, 1943, 1955, 1960, 1961 surpassed the previous one.
- To add to the plight of its people, in between 1967 to 2003, floods of periodic nature occurred almost every year in between 1967-1975, 1977, each year

between 1980-82, 1985, 1990, 1992,1994, 1995, 2001 and 2003. The number of such destructive i.e. flood occurs equalled 20 times.

- Total of all such chronic, periodic and yearly occurrences of floods in **Orissa** during 1886-2003 i.e. during the last one hundred thirty-six years are as many as 282.

Drought

- Like flood, **drought** is recurrent in **Orissa**. In most of the years, droughts and floods are experienced simultaneously because of excessive rainfall in some parts of the catchment basins and low rainfall in other regions.
- Records reveal that there were droughts in 1841-42, 1842-43, 1849- 50, 1850-51, 1954-55, 1965, 1966, 1967, 1979, 1984, 2000, 2002 and 2003. In the annals of **history**, the great devastating **Orissa** famine, i.e. *Na Anka Durbhikhya* was mainly because of extensive **drought** in 1865.
- Just like floods, droughts wreak in a lot of suffering to the **Orissa** people - the damages being overwhelming by nature. Every alternate year, either a **drought** or flood has become a recurring phenomenon in the State.

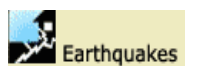
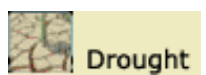
Famine

- **Orissa** is also marred with the worst hit famines in the state's **history**. Famines are the inevitable consequences of flood, prolonged **drought**, cyclone and wars. The records evince about the occurrence of many famines in the 14th,the 15th and in the 16th centuries.
- The famines of 1770, 1774-75, 1780, 1792, 1836-37, 1837-38, 1865-66, 1940-41 and 1942-43 were the major ones.
- However, the horrors of famines of 1866 cannot be wiped out from the recorded annals of Orissan **history**. It is believed that nearly one fourth of **Orissa's** total population were wiped out.
- The earlier section, gives an appalling view of the threats looming before the present and future of the State. This was also rightly pointed out that "the State of **Orissa** is a flood ravaged, **drought** prone, cyclone hit and famine stricken land. Tornado affected and seriously affected by Heat wave "

Research needs are:

- a) Development of anti-malarial drugs to fight resistant strains
- b) Development of malarial /filarial vaccines and other effective drugs against, chickengunia /dengue, diarrhea, typhoid, jaundice.

This is one example but things are accelerating and vulnerability has gone up to maximum extent and Asia bears the brunt the impact of global climate change



- **Disasters Update !01-10-08***[Jodhpur: 150 dead in stampede](#)
- **30-09-08***[At least 103 killed in stampede in Chamunda Devi temple in Jodhpur](#)
- **29-09-08***[Major rivers receding in UP](#)
- **28-09-08***[Water level normal in Yamuna](#)
- **27-09-08***[Flood situation improves in Bihar](#)
- **26-09-08***[56 die in Orissa flood as 8 lakh remained marooned](#)
- **25-09-08***[Rs. 1,600-crore plan to tackle natural, man-made disasters](#)
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- **23-09-08***[Home Minister to visit inundated regions in Orissa, UP remains grim](#)
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- **19-09-08***[Flood causes damages in four states](#)
- **18-09-08***[Heavy rain causes deaths and damages in Orissa and Gujrat](#)
- And many from 2009-10 , 11, 12 now phailin-2013, lehar a

“Hard Truth, Real Truth, Naked Truth and An inconvenient Truth”

Disaster vulnerability to climate adaptation and **Half Truth** for livelihoods resilience in Asia

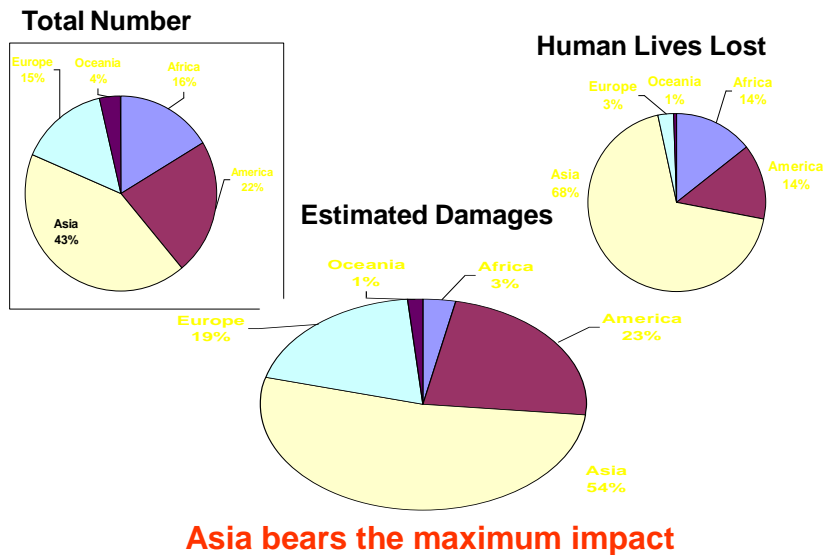
Excess Water Only 2007: frequency & magnitude Of vulnerability

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 - [Nepal: Flash Floods/Floods - Jun 2007](#)
 - [China: Floods - Jun 2007](#)
- [Bangladesh/Myanmar: Floods and Landslides - Jun 2007](#)
- [India: Flash Floods/Floods \(Orissa, Bihar, Assam\) - Jun 2007](#)
 - [South Asia: Floods and landslides - Mar 2007](#)
- [Afghanistan: Floods and avalanche - Mar 2007](#)
 - [Philippines: Typhoon Utor - Dec 2006](#)
 - [Philippines: Guimaras oil spill - Aug 2006](#)
 - [Indonesia: Floods and Landslides - Feb 2006](#)

| Disaster Impacts in Various Regions (1963 -1992) | | | | | | |
|--|------|---------|--------|--------|-----------|-----------------|
| | Asia | America | Europe | Africa | Caribbean | Pacific Islands |
| Flood | 130 | 35 | 10 | 19 | 2 | 6 |
| Drought | 6 | 0 | 0 | 15 | 0 | 0 |
| Famine & Dearth of food | 1 | 0 | 0 | 3 | 0 | 0 |
| Tropical cyclone | 84 | 13 | 0 | 5 | 11 | 40 |
| Rain storm, etc. | 27 | 10 | 1 | 4 | 0 | 4 |
| Earthquake | 34 | 20 | 22 | 22 | 0 | 4 |
| Landslide | 26 | 20 | 3 | 3 | 1 | 1 |
| Epidemic | 41 | 16 | 1 | 74 | 0 | 0 |
| Others | 31 | 21 | 7 | 5 | 1 | 7 |

Continental Contrasts



3. What are the key components of human/ social resilience to climate change and how can they be evaluated (e.g. measured or ranked)?

Agriculture

It is being observed that our food basket is getting narrower both in terms of vegetables and cereals and pulses. It is now well known that Green revolution has bypassed coarse cereals and minor millets besides pulses and large number of vegetables. Further, with increasing urbanization as people leave rural areas to live in urban areas they get disconnected from their past and along with that also forget the variety of millets and vegetables they used to collect from the wild. Thus, there is a steady erosion of genetic diversity and with that the rise of vulnerability of the people.

Many cereals, vegetables, pulses which have pest resistance, drought resistance, disease resistance and resistance to climatic variability are disappearing and/or knowledge about them is disappearing. It is necessary that these forgotten food items are brought back into our food basket so that greater diversity provides stability and sustainability of food production system.

Environmental costs are becoming enormous. Subsidy for fertilizer etc is becoming unbearable for government and without subsidy inputs will not be affordable for the farmers. Alternative agriculture becomes inevitable.

Research is necessary to raise food production in a sustainable manner. Package of practices for sustainable agriculture and suitable for different agro-climatic conditions are to be developed and promoted. Study on Cultural biodiversity is essential to know that adaptive capacity and coping mechanism in relation to food security resilience of rural and tribal community during critical and lean period/ stress management or in disaster situation.

- a. Identification of these food items, collection and conservation
- b. Assessing their nutrition value, Increasing their productivity
- c. Development of flood resistant rice varieties
- d. Development of post harvest technology and value addition

The ultimate carbon sink is the forest. In Orissa thousands of hills and hillocks are without trees; yet, the root-system continues to exist and given protection new shoots will emerge from old roots and one gets an excellent regenerated natural forest in no time. To facilitate protection on a large scale what is really necessary is releasing community initiatives. The community will be encouraged to promote and protect these countless hills and hillocks, if and only if the community is assured of tenurial security and rights over the forest.

Research needs:

Motivating factors to protect forest

Local specific appropriate management practices

Product sharing, value addition of forest produce, providing and promoting market linkages

Experience of other places/regions in linking tenurial security with forest protection has to be initiated.

Water

With more emphasis on Industrialization now there is greater pressure on available water. Industry has emerged as a major competitor for water. Further, mining and industrial activities are polluting the water bodies and ground water. The problem is being complicated by increasing use of agro-chemicals, pesticides and fertilizers which find their way to all water sources including ground water.

Research needs:

- To reduce water requirement of industries and study ways of growing crops with less water
- To find cheaper and effective ways to remove pollutants from water to make it drinkable and fit for agriculture crops
- Input intensive agriculture has raised production to a great extent but now it is evident that productivity cannot continue to rise beyond a point.
- Focus should be more micro- water projects within community reach and rain water conservation and retention with adequate backward and forward linkages. It is necessary to study methods to increase community access and community involvement in water management.
- Catchments protection with integration of technical, mechanical, , agrosrological and biodiversity conservation initiative

Other References:

<http://www.zeenews.com/news599578.html>

Washington: India and China rank 123rd and 121st in **pollution control**

Respectively, reflecting the strain rapid economic growth imposes on the environment, according to the 2010 Environmental Performance Index (EPI). Developing countries can shift to lower-carbon paths while promoting development and reducing poverty, but this depends on financial and technical assistance from high-income countries, says *World Development Report 2010: Development and Climate Change*

<http://siteresources.worldbank.org/INTWDR2010/Resources/5287678-1226014527953/WDR10-Full-Text.pdf>

There are several studies have made as both climate change and extreme poverty are human rights matter .It considers seriously full realization of many in addressing to respect, protect and fulfill human rights and resilience.

http://typo3.fao.org/fileadmin/user_upload/fsn/docs/The_Governance_of_Hunger_A_M_JLV_FINAL_3.pdf

World Day to Combat Desertification 2010 kicks off

- **Date:** 17 Jun 2010
Source(s): [United Nations Convention to Combat Desertification \(UNCCD\)](#)

Message from Luc Gnacadja, Executive Secretary, United Nations Convention to Combat Desertification (UNCCD)

Six to ten inches (18-25 cm) of topsoil are all that stand between us and extinction. There's far more to this than food. The things that live in and grow from this irreplaceable and finite resource also keep us clothed, the air and water clean, the land green and pleasant and the human soul refreshed. Only now are we starting to comprehend how the tiny life forms in soil sustain productivity and the greater environmental balance.

Already, we know that the species that live in soil are far more abundant than first thought. Microbes in the soil make up most of the biomass of life on earth. They may lack the charisma of the tiger or the orang-utan, but the sheer prevalence of soil-dwelling fungi, archaea, bacteria, rotifers and nematodes alone puts other species in the shade. If we placed all the microbes found in soil on one side of a scale and all surface-dwelling animals on the other, the soil microbes would quite literally outweigh them. Understanding just what their function is thus vital to our broader grasp of environmental management, climate change and human development. In developing countries, water for agriculture consumes 70 – 90% of water use.

To meet the needs of a growing population, more food must be produced using less water. The CPWF has taken on this challenge from a research perspective. The initiative brings together research scientists, development specialists, and river basin communities in Africa, Asia and Latin America to create and disseminate international public goods (IPGs) that improve the productivity of water in river basins in ways that are pro-poor, gender equitable and environmentally sustainable.

<http://www.waterandfood.org/>

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- Improved health through better nutrition, lower agriculture-related pollution and reduced water-related diseases
- Environmental security through improved water quality as well as maintenance of water-related ecosystems and biodiversity.

Global Disaster Events

| | |
|---|--|
| (11/13/08): Global Climate Change | (06/18/08): June 2008 Flooding on Mississippi May Eclipse Great Flood of 1993 |
| (10/31/08): Pakistan Earthquake | 06/17/08): Floods in China Displace 1.27 Million |
| (10/30/08): Scenario Earthquakes for California | 06/17/08): Quake-Stricken Sichuan Province Now Facing Seasonal Floods |
| (10/21/08): Hurricane Omar | 06/17/08): Flooding Rivers in USA Midwestern States Force Thousands to Evacuate |
| (10/14/08): Southern California Wildfires | 06/11/08): Providing for 15.5 Million Homeless in China |
| (09/29/08): 2008 Tropical Storm/Hurricane/Typhoon Season | 06/11/08): Anatomy of the June 2008 Indiana Flooding |
| 09/29/08): Hurricane Kyle | 06/04/08): China Earthquake: Twenty-one days later |
| 09/18/08): Hurricane Ike - After Landfall - Sept. 13, 2008 | 06/03/08): A Step Toward Normalcy - Myanmar To Reopen Schools in Irrawaddy Delta |
| 09/11/08): Hurricane Ike - A CAT 4 Storm | 06/02/08): Survivors of Cyclone Nargis Overcome Huge Odds in Myanmar |
| 09/08/08): Tropical Storm Hanna | 05/26/08): Tornadoes Strike Iowa and Minnesota |
| 09/02/08): Hurricane Gustav | 05/26/08): Day 14: Earthquake Lakes Ready to Burst |
| 09/02/08): Tropical Storm Fay, August 16, 2008 | 05/19/08): China Earthquake Disaster: Days Five-seven |
| 08/12/08): Seismic Zonation: The Challenge Facing China | 05/15/08): China Earthquake of 12 May 2008: What Happened? |
| 08/08/08): Lessons From Cyclone Nargis | 05/15/08): Cyclone Nargis: The ?Perfect Storm? for causing a catastrophic disaster |
| 08/07/08): Disaster Lessons | 05/15/08): Magnitude 7.9 Earthquake Strikes China's Sichuan Province |
| 08/05/08): M6.1 Aftershock of the May 12th Wenchuan Earthquake | 05/14/08): Cyclone Nargis Strikes Myanmar (Burma) |
| 08/05/08): Seismic Zonation | 04/30/08): Six Tornadoes Strike Suffolk Area in SE Virginia: April 29, 2008 |
| 08/04/08): Tropical Storm Edouard: August 3, 2008 | 04/30/08): Wildfire in San Gabriel Mountains, Southern California: 26-29 April |
| 08/03/08): Recent Earthquakes | 04/30/08): World's Largest Earthquakes: 1906-2008 |
| 08/03/08): Seismic Zonation: A Policy Tool for Reconstruction... | 04/17/08): Nevado del Huila Erupts |
| 07/23/08): Hurricane Dolly | 04/15/08): Forecast of Atlantic Hurricanes: 2008 Season |
| 07/22/08): Notable Natural Disasters During 2008 | 04/14/08): Floods and Landslides in Peru |
| 07/22/08): 2008 Tropical Storm Season Begins Around the Globe | 03/20/08): Floods in Midwestern USA |
| 07/20/08): The Great Midwest Flood of 2008 Prompts a Return to the Buyout Strategy in Five States | 03/10/08): Recent Earthquakes - 2008 |
| 07/10/08): China Earthquake Reconstruction Underway | 02/17/08): Severe Winter Storm Impacts 17 Provinces in China |
| 07/07/08): Hurricane Bertha | |
| 07/07/08): Eight Dangerous Volcanoes | |
| 07/07/08): 1900 Firefighters Still Battling Wildfires in Northern California | |
| 07/01/08): The Great Flood of 2008: Midwestern USA | |
| 07/01/08): Wildfires in Northern California | |
| 06/27/08): Floods in Midwest and Along Mississippi River Create Economic Crises | |

4. Who are the real adaptation decision-makers / where are adaptation decisions really made?

It is all about global or IPCC, this is ok. But impact is at community level.

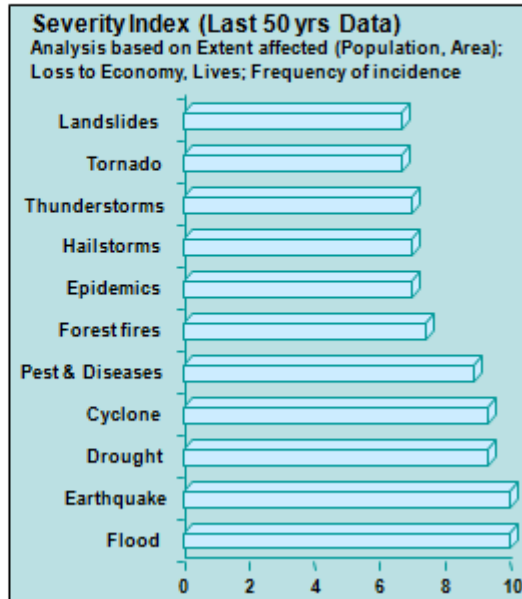
It is imperative that we build our knowledge base with inputs from the masses and go to masses with the knowledge available with us. That is to say, what is required is cross learning

Hence there are following few basic thrusts on human rights and climate justice have to be discussed well:

- “Freedom from Hunger” and right to food in a changing climate
- Right to Health in wetter and warmer condition
- Civil and political rights in climate constrained community
- Displacement, adequate housing /shelter and human rights in degraded and unstable environment
- Obligation to respect and protect :mitigation and adaptation for most vulnerable to impacts of climate change
- Citizen action and community resilience to full fill the human rights in the context of climate change
- Harnessing Green growth for the realization of Human Rights
- Linking Governance-Gender-Livelihoods-Climate Justice: as people matter

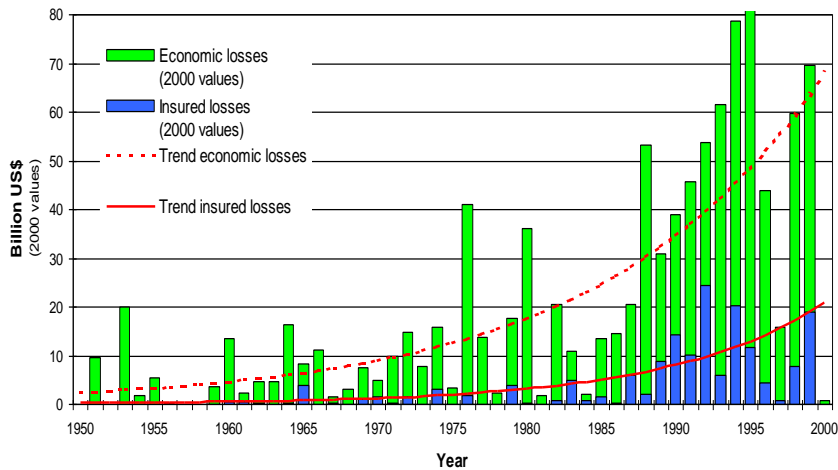
Disasters in India - Vulnerability

•The Indian Sub-Continent is among the world's Most Disaster-prone Areas



Great Natural Disasters 1950 - 2000

Economic and insured losses with trends



5. What assessment tools and decision-making frameworks exist to help policymakers and practitioners choose and implement the most appropriate adaptation measures?

- Climate change is likely to increase mass migration, to put increasing strain on health systems due to an increased incidence of disease, threaten food and water security, and lead to loss of shelter, land, livelihoods and culture, not to mention the threat of conflict. However, the climate change debate has, so far, given little attention to human rights aspects. The most severe effects of climate change will occur in the poorest countries, which frequently have weak human rights protections. It is critical that human rights criteria are included in climate change planning and policies.
- The International Council On Human Rights Policy ([ICHRP](#)) has jointly published a new book '[Human Rights and Climate Change](#)' with Cambridge University Press which examines the human rights dimensions of climate change. It considers the questions raised by climate change policies, such as accountability for extraterritorial harms; constructing reliable enforcement mechanisms; assessing redistribution outcomes; and allocating burdens, benefits, rights and duties among perpetrators and victims, both public and private
- There will be more natural catastrophes in future. But these will not always involve horrific headlines and images of hurricanes and tsunamis. More commonly and will be cumulative and unspectacular. People who are already vulnerable will be disproportionately affected. Slowly and incrementally, land will become too dry to till, crops will wither, rising sea levels will undermine coastal dwellings and spoil freshwater, species will disappear, livelihoods will vanish. Occasional cataclysms will exacerbate these trends. Mass migration and conflicts will result. Climate change will, in short, have immense human consequences..
-
- Human rights law is relevant because climate change causes human rights violations. But a human rights lens can also be helpful in approaching and managing climate change. The human rights framework reminds that climate change is about suffering – about the human misery that results directly from the damage we are doing to nature.
- Many communities already feel the adverse effects of warming temperatures – yet so far few remedies are available. Climate change already threatens the livelihoods of peoples in distant corners of the world, from North Alaska to the Pacific islands. It is contributing to rising prices for grains and staples that are undermining food security for millions, particularly in countries with unstable weather patterns. It poses a profound threat to development in states that currently lack the resources to fulfil basic human rights. The scope of these problems – and of the action required to treat – reach beyond previous human challenges. Climate change shows up

countless weaknesses in our current institutional architecture, including its human rights mechanisms.

▪ Fundamental human rights and freedoms are described in the Universal Declaration of Human Rights as “freedom from fear and want” has been proclaimed as the highest aspiration of the common people, (<http://www.un.org/en/documents/udhr/>) The declaration further proclaims that every one as a member of society.. is entitled to realization, through national and international cooperation and in accordance with the organizations and resources of each state, of the economic and social and cultural rights indispensable for dignity and free development of personality. Human Rights standards offer a valuable perspective with which to understand the impacts of climate change on the world’s most vulnerable people. And this has clarified the obligations of states both collectively and individually, to minimize that results from climate change and help vulnerable people and community adapt to its inevitable effects. Office of High commissioner for Human Rights has established that “looking at climate change vulnerability and adaptive capacity in human rights terms, highlights the importance of analyzing power relationships addressing underlying causes of inequality, discrimination and gives particular attention to marginalized and vulnerable communities of societies especially people living in poverty, climatic variances, livelihoods resilience.

▪ Vulnerability the degree to which people are susceptible to the adverse impacts of climate change i.e level of resilience and capacity to cope of community. Persons living in a developing country faced 79 times greater risks of being affected by climate induced disaster .262 million people affected by climate disasters annually from 2000 to2004 over 98 percent were living in the developing world.

1. What are the most commonly discussed and implemented adaptation approaches for protecting against, reducing sensitivity to, and allowing recovery following, weather-related hazards?

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2. Are there any studies comparing the success of different adaptation approaches for a particular climate change impact or weather-related hazard? How was success measured?

Yes so may studies done , but the concept of resilience is new and yet to show the results.

The costs of ignoring climate change have been estimated at more than that of the two world wars and the Great Depression (5 to 20% of GDP) (Stern Report).

By 2025 two-thirds of the earth's population will suffer water shortages.

A temperature rise of 2° would dramatically shrink the land available for growing Robusta coffee in Uganda and restrict it to upland areas.

temperature rise of 2 to 3.5° in India would reduce farmers' incomes by between 9 and 25%.

- The cost of tackling the problem, however, could be around 1% of global GDP if mitigation policies are well-designed (Stern Report).

- Recent figures from the UNFCCC put the costs of adaptation for developing countries at between \$28 to \$67 billion in 2030.

1° C

If the world's temperature increased by 1° C, at least 10% of land species would face extinction.

2035

Glaciers in the Himalayas are likely to disappear by 2035, affecting the water supply of three-quarters of a billion people in Asia.

200 million

By 2050, 200 million people could be rendered homeless by rising sea levels, floods and drought.

70%

Between 1970 and 2004, global emissions of greenhouse gases increased by 70%.

\$6 billion

Humanitarian responses to disasters cost donors around \$6 billion every year..

- Climate change brings the risk of increases in serious diseases such as malaria, dengue, yellow fever and polio.
- Rainfall in the wet season in Pakistan could increase by 5 to 50% by 2070, which would have significant impacts on cotton, the country's main cash crop.
- Over 3 billion people in the Middle East and the Indian sub-continent could be facing acute shortages of water – affecting productivity and jobs.
- Between 1900 and 2004, 73% of disasters were climate related; 94% of disasters and 97% of disaster-related deaths occur in developing countries.
- By 2020 between 75 and 250 million people in Africa will be facing increased water shortages.
- Natural disasters can set back a country's economy by years.
- In 1998, Hurricane Mitch hit more than 25% of households in Honduras and led to a 7% drop in agricultural output. The number of people living in poverty in Honduras is now growing..
- Unpredictable rainfall, together with rising sea levels and higher sea temperatures will lead to more frequent storms, floods and droughts.
- The area of the world stricken by drought has doubled between 1970 and the early 2000s. In Africa fertile land is already turning to desert.
- By 2020, climate change is predicted to reduce some African farming harvests by 50% Sea levels are rising at a rapid rate (having risen by 20cm over the 20th century);
- in Asia, the homes of 94 million people could be flooded by the end of the century, leading to large-scale migration.
- Eleven of the last 12 years rank among the 12 warmest years on record.

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- Eleven of the last 12 years rank among the 12 warmest years on record.

3. To what extent, and under which circumstances, can ecosystem-based approaches be integrated with other adaptation approaches (eg. those that involve hard infrastructure, technology and social interventions)?

The study would have the following key components:

What are the practices, process, principles, ethos, bondage, knowledge, know-how, information, wits and wisdom, folk lore, habit, habitats, species of plants and organisms, ecosystems and animals etc., lives and livelihood displacement due to development process, replaced and by what means or still persists in relation to adaptation to vulnerability culturally. Outcomes, regeneration, restoration, rehabilitation, threats, hazards, opportunity to rebuild would constitute some of the focus areas of the study.

This envisages very broad based initiatives in this context which can be mentioned as follows:

- **Links to the broader view of poverty** and poverty alleviation that goes beyond just income to include empowerment, capability
- Highlights the crucial **role of 'context' (especially vulnerability context)** – and how this influences the asset base, the selection of livelihood strategies, and the outcomes for households.
- Giving space to advocate **local initiatives and linking global perspectives** - categorize the strategies that make up their livelihoods diversification & convergence

- **Build on what exists** - a multidimensional, **integrated perspective** that unites the concepts of economic and entrepreneurship with ecological development for value addition that will help to reduce vulnerability and environmental sustainability.
- **Capacity Building of smaller CBOs & NGOs** for resource building approaches and innovative adaptive knowledge dissemination and development of good practices ,simultaneous programming to make self sufficiency and self employed
- **Institution building and enabling environment** with an objective of enabling environment and wider replication and scaling up for reducing vulnerability thru a network approach.
- **To Create a coalition of civil society organizations** (NGOs, CBOs and PRIs partnership) for value addition to ensure **information flow** and lasting solution
- **Support system and decentralized monitoring process** and Complementary and supplementary to Government initiatives
- **Demystification of technology ICT** with appropriate and creative use to enhance income, nutrition & livelihood support system to address the menace
- **Value chain and business development** has to be developed in order to sustain the development and business
- **Model building garnering with Governance and Gender**

This is important to develop **long-term vulnerability-mitigation strategies** to reverse the ill effects of repeated disasters, climate change adaptation and environment sustainability and break away from the vicious circle

4. In an ideal multi-criteria analysis, by which criteria should different adaptation approaches be compared and assessed?

*It is clearly spell out that ecology and economics share a strong organic bondage. Under the changing climatic situation (arising as a result of natural phenomena and or outcomes of human made developments), the relationship between the two has been badly affected causing disastrous harms to human lives and property. A lot is being talked about the causes of disasters, technical know-how on disaster management and rehabilitation. But, developing understanding on existing coping mechanisms at the regionally and focussed to community level and then propagation of this understanding at a broader level has remained an area of neglect. Keeping this in view, it is highly important to initiate a study on **Cultural Biodiversity Conservation as a process to vulnerability adaptation & Community water resource management is highly necessary.***

5. To what extent, and under which circumstances, can ecosystem-based approaches play a role in climate change adaptation and / or disaster risk reduction (drawing on examples of weather-related hazards)?

There three thing need to be added here.

One is Ecosystem based approach is the best approach for climate adaptation: . thus local biodiversity conservation relating to forest flora and fauna, that can be used for protection, consumption, promotive and provising of resource use, operation and management on a sustainable way or leading to sustainble consumption production and environmental sustainability.

Use of land mass in climate resilient cropping, low water requiring crops, cover cropping, crop rotation and crop diversity, embankment plantations and protection of land mass from degradation and managing the river ecosystem.

Without Water initiative no thought of climate adaptation, series of micro- water harvesting, recharge, moisture retaintion, in any form be it technically , mechanically or biologically ,percolation of surface water management would be the ideal , but larger sectors of water initiatives is required if possible ut there are other implications on displacement , resettlement

6. What are the appropriate scales for, constraints, distributional consequences and trade-offs of ecosystem-based approaches?

Scale is a must in order to validate the learning, Making some models at various geo climatic zone and various ecosystems. Again Region specific is also imoptant.

The Resilience Academy

Exploring Livelihood Resilience
15–21 September
Dhaka, Bangladesh



UNITED NATIONS
UNIVERSITY

UNU-EHS

Institute for Environment and Human Security



ICCCAD

International Centre for
Climate Change and
Development

at
University of Dhaka, Bangladesh
in partnership with UNU-EHS



Munich Re
Foundation
From Knowledge
to Action

5 November 2013

Dear Dr. Belinda Gordon, and Esteemed Colleagues of the Royal Society's Human Resilience to Climate Change and Disasters Project,

As per our dialogue with Dr. Belinda Gordon on the nature of our research agenda, on behalf of the Resilience Academy research team, I enthusiastically submit our original work for your consideration. Here you will find 1+18 abstracts that represent original scholarly papers in preparation. The first abstract on livelihood resilience amidst global transformations, which has been written as a Perspective Article for Nature Climate Change, serves as a bridging piece for the remaining 18 abstracts. Collectively these 18 abstracts argue that complementing resilience with livelihoods perspectives overcomes the principal conceptual challenges that resilience faces. Livelihoods are the framework upon which all human organisation rests, and the livelihoods of the world's poorest populations are most vulnerable to the stresses wrought by climate change. To situate resilience where it matters most, it is imperative to advance research and conceptualisations of livelihood resilience amidst major drivers of global transformation. For this purpose, we convened the Resilience Academy, and have embarked on this research agenda collectively.

We hope that you will find our work relevant and useful. Our sincere appreciation for your consideration.

On behalf of the Resilience Academy,

David J. Wrathall, PhD
Associate Academic Officer

United Nations University - Institute for Environment and Human Security (UNU-EHS)
Environmental Migration, Social Vulnerability and Adaptation (EMSVA)

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Perspective Article for Nature Climate Change

Livelihood resilience: Embracing the transformation of people's lives amidst adaptation to climate change

Interest to broad scientific readership:

Resilience is increasingly used as a framing concept for those studying and working on human responses to climate-related impacts. This perspective article provides readers with a summary critique of dominant approaches to resilience building, using select empirical examples to construct a livelihoods approach to resilience that puts people and agency at the centre, highlights social and political factors influencing people's responses to climate change, and embraces uncertainty and transformational change. Given the ability of resilience to act as a 'boundary concept' linking social and ecological systems, the article will be of interest to a broad range of readers from ecology and the natural sciences, engineering, development studies, geography and other social sciences.

The paper will be co-written by authors from the 2013 Resilience Academy held in Savar, Bangladesh during September 2013.

Title:

Livelihood resilience: Embracing the transformation of people's lives amidst adaptation to climate change

Lead author:

Thomas Tanner

Summary paragraph:

Resilience is rapidly emerging as a central concept for those working on adaptation to climate-related impacts, while academia is undergoing a 'resilience turn' across a wide range of disciplines¹. This perspective article, based on a 'Resilience Academy' of international researchers in Bangladesh, argues that the growing likelihood of dangerous climate change, the limits to reactive adaptation strategies, and imperative of climate justice mean that the resilience concept requires a reorientation². We call for greater attention to social and political factors influencing people's responses to climate change, centred on people livelihood systems and with greater emphasis on transformational changes³. We begin by examining approaches to resilience, from simple use of resilience as an understandable, integrative term, through a focus on bouncing back from shocks, to more complex evolutionary approaches that draw on social-ecological systems theory⁴. Using empirical examples, we build constructively on emerging critiques by outlining the use of a livelihoods framework to stress the social, political and normative dimensions of resilience⁵. Crucially, we argue that taking a livelihood resilience approach to climate change adaptation allows greater emphasis on people and their agency at the same time as considering adaptive livelihood systems in the context of broader development transitions and transformations.

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PART 1: Livelihood resilience amidst global transitions

1. A Typology of Place-Based Risks: Toward Inter-community Livelihood Resilience Learning

Abstract

There is a rich empirical literature, comprised mainly of case-study examples documenting the vulnerability and resilience of diverse communities. While case-study methodologies have their strengths, they are often criticized for being of limited application: the learnings from single case studies are not quickly or easily translated/transferred to support knowledge production, and investigation in other contexts. In order to make better use of existing case study research and contribute to theoretical elaboration and identification of key research questions across existing cases, we propose a typology of climate-vulnerable communities, along with examples of each. These typologies make it possible to generalize the response options available by type in order to facilitate comparison of response options across types. The aim is not only to aid in theoretical elaboration and identification of key research questions in the field, but also to help communities and experts to more quickly identify relevant communities which might be geographically or even temporally distant but face similar challenges.

Keywords:

climate change risk; resilience; communities; case studies; analogues

Authors:

Katherine King, Frank Thomalla, Koko Warner, David Wrathall

2. Livelihood Resilience: Lessons for climate change adaptation from small island communities

Abstract

Home to important flora and fauna, rich cultural roots and heritage, island communities are characterized by deep social ties to the environment. However, due to environmental degradation, the impacts from climate change, both slow (e.g., sea level rise) and sudden onset (e.g., hurricanes) events, and changes to livelihood structures and opportunities, islands throughout the world are facing increasing threats. In order to understand and appropriately address livelihood risks to these communities and to identify opportunities for resilience building, there is an urgent need to shed light on the historical and cultural context of island inhabitants and ecosystems. The best approaches to resilience building will need to build upon local knowledge and ground themselves in established practices that have been developed by island communities over centuries, but are heavily impacted by current political and economic trends.

This paper presents several multi-scale case studies around the world, which offer a historically informed review of the cultural, political and economic systems and influences on island resilience. We then move the discussion to the current state of vulnerable populations, ecosystems and livelihoods, and opportunities for restoring and enhancing resilience through traditional and local knowledge and institutionalizing a long-term agenda to build social and environmental justice. In doing so, this paper will demonstrate how pioneering small island communities can become inspiring champions of livelihood resilience to global environmental change. Findings indicate the challenges and constraints presented by deeply-rooted colonial and neo-colonial histories. Our conclusions highlight best practices at the local, regional and national-scale for addressing these challenges through education, health, intergenerational knowledge sharing, and innovative livelihood strategies such as increases in mobility patterns. These practices ultimately help to reduce livelihood vulnerabilities by contributing to the creation of national and community level adaptive capacity to climate change; and help to forge a stronger sense of global community between small islands and non-small islands across the world.

Keywords:

Livelihood Resilience, Climate Change, Small Island States, Colonialism, Political Economy, Traditional Ecological Knowledge

Co-authors:

Roger-Mark De Sousa, Sarah Henly-Shepard, Karen McNamara, Raihana, Nishara Fernando, and Raphael Nawrotzki

3. Do Sustainable Livelihood Programs Lead to Sustainable Livelihood Outcomes? Evidence from the Asia Pacific Region

Abstract:

Catastrophic events that require intensive recovery efforts include conflict, natural hazards, and slow-onset climate disruptions. These events have considerable social and economic costs for impacted nations and present dilemmas on how to best use limited resources to stimulate growth, social resilience, the resurgence of healthy markets, and the restoration of vital livelihoods. Whether the effects of climate change, crises, and disaster are catalogued at the macro (collective) or the micro (individual) level, they have been shown to derail previously existing development initiatives and poverty reduction efforts and create circumstances that result in the economic destabilization and impoverishment of vulnerable populations. Livelihood interventions help move communities past short-term humanitarian emergency measures towards longer-term stability and self-sustaining economic activity. Using ethnographic methods, this paper examines whether sustainable livelihood programs lead to sustainable livelihood outcomes. It presents and analyzes three case studies from the Asia-Pacific Region that detail the practice, models, and local context of recent sustainable livelihood interventions and advances knowledge about sustainable livelihood models and their usefulness in practice. Our analysis of these case studies suggests that current intervention practices often fail to produce intended results and the gap between a solidly grounded body of theory and the complexities of real world practice is large. Shortcomings in the practical implementation of sustainable livelihoods programming range from insufficient needs assessment and monitoring and evaluation schemes to inexperienced practitioners, institutionalized corruption, competition for limited resources between organizations involved in humanitarian endeavors, the manipulation of program data by NGOs in order to produce optimal views of their work and secure continued donor support of their operations, and the short-term nature of most interventions. Recommendations for a variety of ways to improve practice and better operationalization of solid theoretical constructs are discussed in the context of the organizational realities that are impacting practice.

Keywords:

Sustainable Livelihoods, Sustainable Development, Asia-Pacific Region, Climate Change, Poverty Reduction Schemes, Performance Evaluation, Vulnerability

Authors:

Laura Olson, Ashiqur Rahman, Malashree Bhargava, M. Nadiruzzaman, Raihana Ferduous, Frank Thomalla.

4. Early Warning Systems and livelihood resilience: Exploring ways to integrate at-risk population from risk predictions to disaster management activities

Abstract

Acute and long-term hazards, both natural and anthropogenic, are increasing in intensity, frequency and complexity. Their related impacts have powerful implications for humanity, particularly populations inhabiting coastal zones, islands and riverine systems or those located in Least Developed Countries. For communities with deep reliance upon natural resources for their livelihoods, such disruptive shocks and shifts in ecological dynamics are even more disastrous, as they impact the functionality and resilience of the ecosystems they are dependent upon and resultantly impair food and water security. While shifts and shocks on socio-ecological systems are increasing, the development of effective Early Warning Systems (EWS) could contribute to foster livelihood resilience. EWS can improve coping mechanisms through short-term mitigation (e.g. tsunami warnings can facilitate risk communication and effective evacuation to save lives) and improve adaptation through anticipating longer-term impacts of natural hazards and climate change (e.g. through identification and warnings of an upcoming drought facilitating preparations in terms of food supply, agricultural practices, etc.). Effective EWS are a principal tool in risk communication for critical decision-making and implementation of risk reduction actions. Improvements in the science of risk predictions have been acknowledged over the past decade. Yet, shortcomings in risk communication, education, capacity building and EWS applications undermine risk reduction at the grassroots level, which contribute to loss of lives and shocks to livelihoods. This paper provides multiple case studies illustrating best practices of EWS development, implementation, monitoring and evaluation at various scales in at-risk communities. Results indicate a large window of opportunities in research and action to significantly improve the way EWS are conceived and applied. The main finding is a need for an integrated cross-scale approach inclusive of bottom-up citizen science, vertical cross-community sharing and top-down information communication. This approach could be reflected into an End-to-End-to-End system, adding a feedback loop to the traditional end-to-end model for EWS, and ensuring the involvement of at-risk population. In other words, the E-2-E-2-E model promotes the cross-pollination of traditional ecological knowledge with Western Science and technological early warning systems, improving risk communication, and collaborative risk management in order to foster livelihood resilience.

Authors:

Marie-Ange Baudoin, Sarah Henly-Shepard, Zinta Zommers, Nishara Fernando, Moises Benessene

PART 2: Livelihoods perspectives on social-ecological resilience

5. Loss and damage in livelihoods from climate change impacts on ecosystem services

Abstract:

Ecosystem service provisioning is a central concern to livelihood resilience. Globally, ecosystem services are estimated to range in value between 16-54 trillion dollars/ year, and offer provisioning, regulating, cultural services to livelihoods. These services directly input and support the livelihoods of the low income populations throughout the developing world. Climate change and climate linked stressors are driving an emerging catalogue of impacts to these services, and result in loss and damage to livelihoods. Loss and damage from climate change is related to the limits on actors' ability to adapt. At a certain stage, "an actor's objectives [including livelihood activities] cannot be secured from intolerable risks through adaptive actions" (Dow, et al. 2013b: 387). Any sort of change at an adaptation limit – continuing in an increasingly vulnerable situation, surrendering a societal objective, or transforming behavior-entails a loss and/or damage. In this paper, we investigate a specific type of loss and damage to livelihood systems that extends through climate-affected ecosystem services related to glacier recession in the Andes, Africa and Asia. At a certain limit, we find abrupt losses of a growing season due to changes in water provisioning. By focusing on losses and damages that cascade through ecosystem services, we shift the loss and damage debate away from a focus on people's recoverable assets toward impacts in social-ecological systems, which are non-recoverable, nor easily quantifiable. These services, in turn, impel a range of non-economic losses and damages, including loss of traditional farming systems, and cultural practices.

Keywords:

Livelihoods, resilience, loss and damage, limits to adaptation

Authors:

Zinta Zommers, David Wrathall

6. Uninhabitability

Abstract:

Climate change is rendering parts of the planet uninhabitable, but “habitability” is somewhat subjectively defined. Harsh but stable conditions, such as the Arctic sea ice or the Sahara can provide perfectly suitable environments for human life, given adequate and place-appropriate tools that are adapted for meeting societal goals, and provisioning livelihoods. However, a more objective definition of "uninhabitability" applies along shorelines, for example, that are frequently and dramatically affected by tropical cyclones, storm surges, flooding, coastal erosion, and deposition. In the latter cases, we see sustained dynamic environmental processes, or a "flickering" between ecological states. Literature on regime shifts and critical transitions is useful for defining states that are uninhabitable (Walker et al. 2004; Lenton 2012; Scheffer 2009). Traditional modes of residence and livelihood practices form the lattice that supports all other societal objectives, but amidst variability and extremes that accompany these “low resilience” states, these tools can lose their utility. But more importantly, in these uninhabitable in-between states, we see a shifting social contract –in particular, a shifting duty of social protection that the state owes its citizens. In regions of Honduras and Alaska that are becoming uninhabitable due to climate-linked stressors, we find a change in the responsibility to protect, a principle in international law, which includes an erosion of entitlements, a contraction of opportunities and disenfranchisement. These suggest that with an ecological shift, there is also a shift in the social contract. This dynamic helps us understand the changing role of the state as places become uninhabitable.

Key words:

Social-ecological systems, resilience, critical transitions, duty to protect

Authors:

David Wrathall, Robin Bronen, Helen Adams, Raphael Nawrotzki, Karen McNamara

7. Identity-based resilience beyond resettlement

Abstract

Climate-induced environmental change, including sea level rise, and associated will increase the situations where habitable land will become compromised, and in some locations uninhabitable. An expected consequence of these changes will be the need for populations to move away from stressed areas, resulting in an increased consideration of processes such as resettlement. Drawing from a history littered with examples of migration and relocation, processes of resettlement have been associated with a decrease in the resilience of the population. This, in part, is a function of how resilience is bound up in place and identity, and associated with the specific characteristics of the location. The objectives of this paper therefore are to develop a more nuanced understanding of: the facets of resilience that are particularly associated with place and identity; how resilience might be transferred to a new location during resettlement; and the timing of voluntary resettlement in order to preserve community and individual resilience. The research applies concepts from social health, migration and sense of place literatures to two different resettlement cases: emergency resettlement post-disaster in Honduras, and planned and voluntary resettlement of a coastal village in Alaska. Findings from these case studies highlight the differences between and challenges of emergency versus voluntary resettlement, as well as the mobile and intangible nature of place and identity, which is critical to maintain resilience. The concern for rising incidences of resettlement around the world drives this paper, as does the need to present concrete recommendations for intervention to maintain resilience during and after such processes. These include the need to prevent the transfer of negative aspects of place and ensure the varied role of physical infrastructure in the new location. The role of self-determination should be front and centre of any discussions around resettlement, as should an active commitment to uphold existing human rights as enshrined in law with a new focus on the importance of place and identity.

Authors: Helen Adams, Karen McNamara, Robin Bronen, Ryan Alaniz, Alice Baillat, Raihana, Laura Olson, David Wrathall, Beth Tellman, Erin Roberts, Koko Warner

PART 3: What is missing from resilience?

8. Resilience: Integrative boundary object or pernicious discourse? Lessons from the climate change and disasters community in Bangladesh and the UK

Resilience has become a popular concept internationally for framing responses to shocks and stresses. While the concept has a range of disciplinary foundations, those working on tackling climate change and disasters have been particularly strong proponents of resilience as a term that captures efforts to manage present day risks and adapt to future threats. Nevertheless, there are a growing range of critiques of resilience as both a theoretical and operational concept (Leach 2008, Cannon and Muller-Mahn 2010, Duit et al. 2010, Bene et al. 2012, Brown 2013). These focus particularly on its poorly developed social and normative dimensions, requiring attention to questions such as: what is being made resilient, resilient to what, and resilient for whom?

In this paper, we employ critical discourse analysis to analyse use of the resilience concept in global policy and operational planning for climate change and disasters. We use empirical material from UK and Bangladeshi organisations, as well as those linking the two countries, to analyse three complementary areas. First, drawing on insights from cognitive science and linguistics, we assess resilience as a construct and metonym that has been transferred from a largely positivist ecology-led science to a highly politicised policy realm. We highlight this transfer as central to many of the critiques made thus far. Second, we extend this analysis to examine the strength of the resilience discourse in terms of its ability to act as an integrative ‘boundary object’. While much discourse analysis of resilience focuses on abstract dimensions, we examine discourse in relation the concrete dimensions of the boundary object in the Bangladesh-UK context, including specific actors, objects, institutions and policy spaces. Third, we examine resilience discourse as a tool for exercising power and advancing specific agendas and interests. This analysis centres on the manipulation of discourse to further instrumental concerns around access to resources and agenda setting. Finally, we consider whether the empirical evidence presented supports more radical critiques of resilience discourse as: an effort by industrialised countries to distance themselves from the (redistributive) social justice dimensions of the global climate change challenge (Justice critique - South Centre); an ideology to mask contemporary processes of accumulation (Marxist critique - Hornborg 2009); a discursive tool to emphasise action at the individual and community level, permitting the further withdrawal of the state from its social contract (neo-liberal critique - Boyden and Cooper 2006).

Authors:

Tom Tanner, Alice Baillat, Chris Lawless, Zinta Zommers, Jixia Lu, Frank Thomalla, Jahed.

9. The Human Rights of Livelihood Resilience: creating a normative standard to improve peoples' standard of living in the face of climate-induced environmental change

Abstract:

Climate-induced environmental change threatens the lives, livelihoods, homes, health, and basic subsistence of human populations all over the world. Livelihood resilience can not occur without the protection of social, cultural and economic human rights. Human rights principles are based on the fundamental freedoms inherent in human dignity. These rights are considered entitlements which transcend the sovereignty of nation state governments.

The International Bill of Human Rights forms the foundation for the international articulation of human rights principles. The Bill includes three documents: the Universal Declaration of Human Rights, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social, and Cultural Rights. Historically, since ratification of these treaties, civil and political rights have been the focus of the international community, with more nation state compliance, public pressure to comply and legal analysis. The human rights and entitlements embodied in the International Covenant on Economic, Social, and Cultural Rights have not received the same amount of attention despite the fact that more than one billion people suffer from malnutrition, lack of access to potable water, sanitation and housing. Climate-induced environmental change is likely to exacerbate these deprivations. Livelihood resilience depends on the inclusion of human rights principles into climate adaptation strategies. A rights-based approach to define and measure livelihood resilience will ensure that the basic needs of people will be met despite the climate change impacts that will alter the ecosystems and infrastructure on which livelihoods depend.

Author:

Robin Bronen

10. Understanding the concrete boundary qualities of resilience

It has been observed that the term ‘resilience’, as it relates to climate change and social-ecological systems, often displays a malleable and sometimes ambiguous character (Brand & Jax 2007). It has been argued that this malleability gives it the loose quality of a ‘boundary object’, namely a linguistic device which, while open to individual interpretation, provides a focus to unite groups and actors who may hold differing perceptions and interests (Star & Griesemer 1989). The increasingly widespread use of the term ‘resilience’ has however raised concerns that its descriptive value risks becoming diluted (Brown 2013). This paper seeks to redress this issue by sketching a new way of framing resilience *qua* boundary object. This framing places greater emphasis on the more concrete manifestations of boundary objects, rather than how they are conceived in abstract terms. I argue that more attention should be paid to the ways in which tangible material, social and spatial elements (people, objects, institutions, spaces etc), may combine, over potentially wide spatial and temporal domains, to realize local instances of resilience. Drawing upon Science and Technology Studies (STS) literature I introduce a framework which could be used to understand how the boundary qualities of resilience manifest themselves in empirical terms. The aim of this framework is to facilitate interpretations of resilience which are both critically aware and practicable. In doing so, this framework seeks to meet key criteria advocated by Brand & Jax (2007): that resilience should be framed in a way which permits its specification to particular objects, but which also recognises the useful versatility of the term.

Author:

Christopher Lawless

PART 4: New directions for livelihood resilience

11. Resilience Framework, Index & Minimum Standards Project

Abstract

Disaster resilience and climate change adaptation work have a history of lingering more in the theoretical than practical and policy realms. Previously identified challenges in Part I include: (1) defining and agreeing upon theoretical definitions; (2) operationalizing theoretical concepts and models into practical frameworks and political tools; (3) the use of frameworks as monitoring, evaluation and accountability mechanisms, through iterative measurement of resilience and adaptation of communities or systems over time, in order to show the efficacy and equity of particular programs, policies or institutions; and, (4) a lack of political, financial and practical capacity and willingness to engage in long-term resilience-building and adaptation efforts, as opposed to reactive, short-term disaster response and relief for which there are substantial dedicated international institutions, guidelines and funding. Based on the significant literature review provided in Part I, and recognizing the potential for improving upon the aforementioned challenges, Part II consists of a guidebook proposing minimum standards for those actors (i.e. researchers, practitioners, donors & government officials, policy-makers and community stakeholders) engaged in disaster risk reduction, resilience and climate change adaptation. The guidebook will offer a flexible framework and repository of current tools and resources, through which programs or policies may be modified according to particular places and conditions.

Authors:

Nick Cradock-Henry, Sarah Henly-Shepard, Roger-Mark De Sousa, Vivek Prasad

12. Data management principles for an integrated framework enhancing livelihood resilience

Abstract

Livelihood resilience entails the integration of socio- ecological systems at different temporal and spatial scales, the understanding of short- and long-term fluxes, and capacity to inform decision making and response at multiple levels of governance. This is increasingly important as the vulnerability of many communities is directly eroded by repeated acute as well as chronic hazards, impacts from climate change, economic shocks and political dynamics, among others. Challenges to understanding and operationalizing livelihood resilience include multiple conceptual definitions, theoretical frameworks, and incomplete and disconnected data sets and case studies, information which is often difficult to access and interpret at different scales. Experience across the world and especially in developing countries shows that decision making for enhancing resilience needs to be supported by robust data management systems and their applications. Further, at community level, livelihood resilience depends on access to and generation of data at the local level. Data management frameworks can play a critical role in facilitating better understanding and operationalization of livelihood resilience, insofar as they provide a common conceptual and operational structure in which to generate and share data, inform decision-making, and promote collaboration across sectors. This paper will investigate the main principles for developing a data management framework in support of livelihood resilience. By looking at representative case studies from low to middle income countries, as well as fragile states this paper offers recommendations to policy makers, practitioners, researchers and communities on how to put in place effective and efficient data management frameworks. This paper also looks at sustainable modalities to build capacity for data management across different scale(s), with a special focus on least developed and fragile states. We expect that the principles presented in the paper will promote and improve data-driven governance for livelihood resilience in addition to providing an improved and innovative approach on data management.

Authors

Vivek Prasad, Gaetano Vivo, Beth Tellman, Sarah Henly-Shepard, Roger-Mark De Sousa, Robin Bronen, Marie-Ange Baudoin, Moises Benessene, Malashree, Zinta Zommers, and Nishara Fernando

13. Community Health Resilience

Abstract

Health is a dynamic state of being that extends greatly beyond merely a lack of disease or illness. The health and well-being of a socio-ecological system includes the health of social systems and individuals, as well as ecosystem health and functionality and the interdependent relationships between them. Linkages between the health of a socio-ecological system, like a community, and its resilience to significant perturbations such as disasters and climate change, seem logical. However, significant disconnect continues between the fields of public health, socio-ecological resilience theory and climate change adaptation. Many adaptation, resilience and vulnerability frameworks fail to include adequate (if any) measures of health, be they mental, environmental, reproductive health, individual or public health, or physical safety and well-being. Understanding the influences of such health measures on other aspects of the socio-ecological system, and vice versa, is critical to contextualizing and operationalizing a more comprehensive approach to community resilience and the underlying dynamics within. In this paper, we critique the bodies of literature contributing to this discussion and provide multiple case studies examining community health resilience at varying scales and settings. The findings from the literature critique and said case studies informed the development of a conceptual framework that illustrates the linkages between community health, socio-ecological resilience and climate change adaptation. The framework is useful as a theoretical, practical and policy-oriented tool, which includes provisions for operationalizing at the community level and carries international policy implications to broadening the resilience and adaptation discussion to be health-inclusive and community-centric.

Authors:

Sarah Henly-Shepard, Clive Mutunga, Jixia Lu, Roger-Mark De Sousa, Ryan Alaniz

14. Gross National Resilience: a call for a paradigm shift

Abstract:

The term “resilience” is fast replacing the formerly overly popularized sister term of “sustainability”: this can be seen through multiple scientific publications, reports from aid agencies (such as USAID and the UNISDR) and seminar topics, which are making resilience the new “buzz word” in the field of development aid. Yet, much like our experience with the latter, debate continues around the many definitions, practical applications and political implications of the word, borrowed from the field of ecological science and applied to development studies and actions. While both terms broadened political and societal foresight to embrace a longer-term scale of thinking, including environmental stewardship, the resilience concept places more tangible importance on the interdependent nature of social and ecological systems, their ability to buffer, mitigate, bounce back and adapt to shocks and stressors. Resilience empowers us to break free of linear thinking, and embrace instead the notions of societal and environmental tipping points, alternative states, and broadens thinking to require flexibility, anticipatory longer-term perspectives of societal transformations. Given the increasing global population and environmental degradation, growing intensity and frequency of hazards coupled with uncertain impacts from climate change, prioritizing resilience-building from the individual to national levels is critical for economic gains, political stability and more importantly, well-being and ultimately our survival. However, current policies and funding in many countries are, not surprisingly, still mired in antiquated ways of thinking, focused on economic metrics and political power as the national agenda, agendas which (even under the guise of sustainable development) may do very little for the vulnerable. Exploring the concept of resilience in the context of development and livelihood subsistence, and its potential real-world applications, this paper raises attention to the cultural, social and institutional ills, ultimately issuing a call for a paradigm shift for governments, international institutions and communities to understand, strive for and demand a new agenda: Gross National Resilience.

Authors:

Sarah Henly-Shepard, Ryan Alaniz, Robin Bronen, Tom Tanner, Gaetano Vivo, Zinta Zommers, Marie-Ange Baudoin, Koko Warner

15. Population Dynamics and Gender in Livelihood Resilience and Disaster Risk Management

Abstract:

The size, structure, distribution, and mobility of human populations, as well the relative roles of men and women within households and communities are central to efforts that enhance resilience and manage disaster and climate change induced risks. Population dynamics and gender are increasingly recognized as key in climate change resilience and disaster risk management planning. However, there is limited integration of these issues at the policy and program levels at the national and sub national levels.

This paper examines the theoretical links between population, gender and livelihood resilience and their role in climate change resilience and disaster risk management. Using case studies from four least developed countries in Africa and Asia, the papers explores opportunities for enhanced integration of population dynamics and gender in livelihood resilience and disaster management planning. From Integrated Population, Health and Environment in Nepal and Ethiopia, to mainstreaming gender in disaster management in Afghanistan and in Uganda's REDD + strategy, the paper highlights important lessons for enhanced integration of population and gender into policy and programming.

Key words:

Population dynamics, gender, disaster management, integration, resilience, policy, programs

Authors:

Clive Mutunga, Malashree Bhargava, Roger-Mark De Souza, and Simon Peter Amunau.

PART 5: Effects of power and violence on livelihood resilience

16. Segregated land use as spatial indicator of lack of resilience in a recovery process: the case of L'Aquila – Italy.

The mismanagement of debris in L'Aquila (Italy) after the 2009 earthquake has delayed the reconstruction and hence the return of the former inhabitants to the city center. The inhabitants of L'Aquila's city center were relocated to 19 new settlements in a kind of forced displacement. These settlements are characterized by the lack of urban facilities, which are sources of livelihood, services, and amusement for the population. The aim of this paper is analyze the relationship between spatially segregated land use and lack of resilience in the recovery process in L'Aquila. This relationship is explained by a) the lack of urban facilities in the new settlements to which communities were relocated after the earthquake, and b) the preferences of inhabitants to move away. Our method consists of four steps: 1) Determination of the most important urban facilities for the relocated community according to different age groups; 2) estimation of the amount and the classification of urban facilities in walking distance from each settlement, by using GIS tools and validation through fieldwork; 3) correlation analysis between the lack of facilities, the distance to the city center, and the preference to move away; 4) regression analysis to determine the explanatory power between the lack of general as well as specific urban facilities, and the level of dissatisfaction with the place to which they were relocated. The results emphasize the importance of the relationship between a high degree of segregation due to the scarce number of urban facilities in the settlements, and the high level of dissatisfaction. Finally, we conclude that this spatially segregated land use can serve as a parameter for the lack of resilience in the recovery process of L'Aquila. We conclude that it is necessary to enrich the new settlements with urban facilities, which offer not only services, but also sources of employment. The presence of urban facilities will contribute to restore the functionality of the city and to increase its degree of resilience.

Keywords:

Resilience, disaster recovery, earthquakes, spatial indicators, monitoring.

Authors:

Diana Contreras, Stefan Kienberger, Thomas Blaschke and Peter Zeil.

17. “Participatory exclusion”: power networks, resources and uneven resilience in post-disaster communities

Abstract:

‘Nature does not discriminate, but humans do’ –a deliberately echoed sentiment in an area affected by Cyclone Sidr— problematises practices of resource distribution in post-disaster situations. While relief and rehabilitation services have the objective of ‘building back better’, the possibility of elite-capture of resource distribution channels jeopardises humanitarian initiatives. This paper strives to understand the political economy of post-Sidr interventions from an ethnographic account. The paper establishes links between study area’s power network and access to resources, finding that marginality is a production of ongoing disaster interventions that favour the relatively well-off people over the structurally poor. Ultimately, humanitarian assistance channels resources through established power networks, thus reinforcing them and producing uneven resilience for different social strata. This paper offers important insights for redesigning the distribution of humanitarian assistance.

Keywords:

Humanitarian assistance, patron-client relationship, marginality

Authors:

Md. Nadiruzzaman, David J. Wrathall

18. Violence as an obstacle to livelihood resilience in the context of climate change in Latin America

Abstract:

Livelihood resilience, or the ability of communities to thrive, depends upon the availability and interactions of five types of capital, produced, natural, human, financial, social. While internal conflict and violence in various countries in Latin America affects all types of capital, this paper focuses on social capital. The continuous erosion of social capital increases cycles of violence, which are further intensified by consequences of climate shocks which include displacement and migration. Furthermore, eroded social capital decreases the ability of communities to survive and recover from extreme climatic events. This paper explores the non-linear feedback loop between violence, social capital, and climate shock in the context of some of the most violent countries in Latin America-El Salvador, Honduras, and Colombia. These three countries illuminate the nature of this complex feedback loop by bringing together previous case studies from the community to national levels including challenges in reconstructing community social capital in Post-Mitch (1998) Honduras, the importance of social capital in community resilience to Hurricane Ida (2009) in El Salvador, and the role of internal conflict after La Niña (2010-2011) in Colombia. We conclude that tackling issues of violence to halt the erosion of and rebuild social capital in Latin America is central to supporting livelihood resilience to climate change in the region.

Keywords:

Resilience, social capital, violence, Latin America, climate change, livelihoods

Authors:

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