Resilience to extreme weather

EXECUTIVE SUMMARY

THE ROYAL SOCIETY

The problem

Extreme weather has a huge human cost that cannot be quantified. Between 1980 and 2004 the economic cost has been estimated to be US$1.4 trillion. This shows that societies are not resilient to extreme weather today, and our analysis shows that the risk it poses is increasing.

Steps should be taken to reduce people's exposure and vulnerability now and in the future. Governments are the main bodies with the resources, oversight and powers to do this.

Climate change will affect the frequency and severity of extreme weather in the future. If emissions of greenhouse gases continue at the current rate, extreme weather is likely to pose an increasing threat to people. Yet even if emission rates are reduced, societies will still need to adapt to climatic changes caused by past emissions. Both mitigation of climate change and adaptation are therefore vital.

Steps should be taken to reduce people's exposure and vulnerability now and in the future.

The risks from climate change can be underestimated if no account is taken of people's exposure and vulnerability: global average climate change metrics fail to highlight that the most extreme changes occur where people live – on land. Using mapped climate and population projections over the next century we show where the growth in vulnerable people exposed to floods, droughts and heatwaves will be concentrated (see example opposite). The risks associated with these extremes will increase in areas of the world that are densely populated. Research is needed to improve the understanding of current risks and accurately model impacts at scales relevant for decision-makers.

Cover image
Waves crashing against a breakwater, Aberdeen harbour.

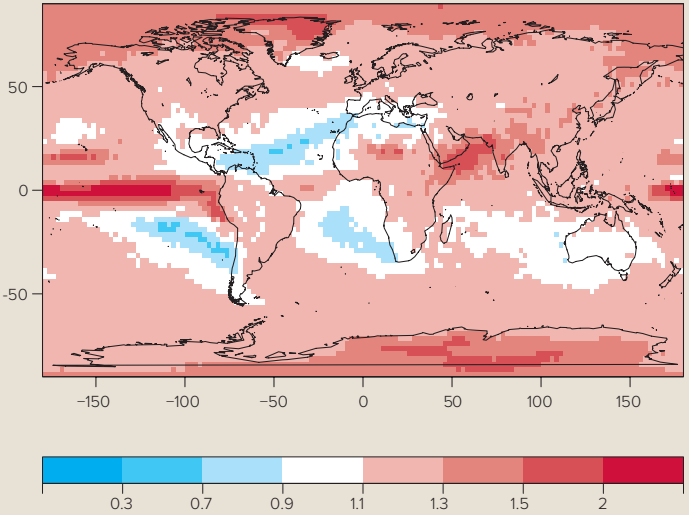
FIGURE 1

Projected changes in 'flooding' due to climate and demographic change.

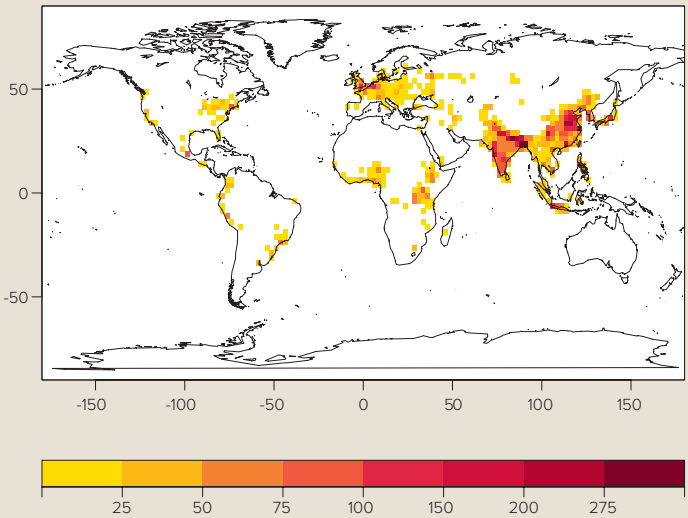
The estimated changes in (a) 'flood' frequency. Those changes in (a) are then multiplied by population density to give the mean increase in the number of times the population per km^2 is exposed to a 'flood' per year – for (b) assuming the 2010 population, for (c) for the 2090 population under the SSP2 population scenario. All for the period 2080 – 2099 relative to the period 1986 – 2005 under an RCP8.5 emissions scenario.

For more maps and the methodology and definitions used to develop them, visit **royalsociety.org/resilience**

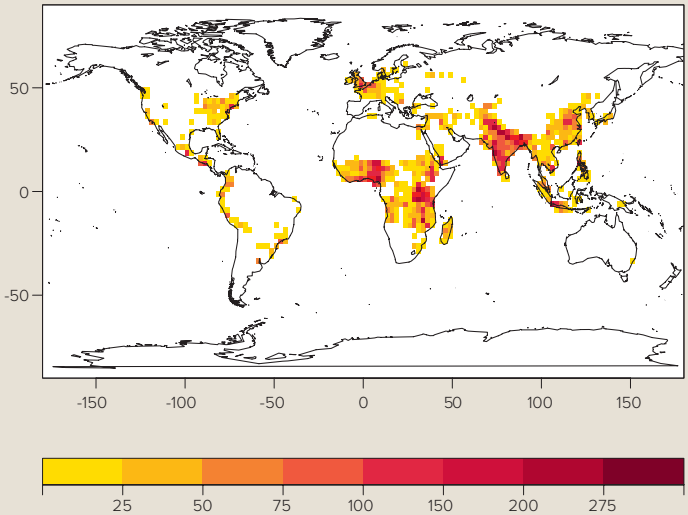
(A) Relative change in 'flood' frequency due to climate change.



(B) Change in 'flood' exposure events with 2010 population.



(C) Change in 'flood' exposure events with 2090 projected population.



What can we do about it?

At the local level, the impact of extreme weather can be reduced by physical interventions to defend people from the hazard, for example a sea wall to prevent flooding or wells in areas prone to drought. We compare the different physical approaches to reduce the impact of four weather-related hazards – coastal flooding, river flooding, heatwaves and droughts.

A portfolio of defensive options to address a range of hazards, involving both physical and social techniques, will be most effective.

Our analysis suggests that a portfolio of defensive options to address a range of hazards, involving both physical and social techniques, will be most effective.

It also suggests that those investing in infrastructure to reduce the impact of extreme weather should look beyond traditional engineering options to those based on natural ecosystems or processes. There is evidence that options which incorporate these ecosystem-based approaches are more affordable and deliver wider societal benefits as well as reducing the immediate impact of the hazard. However, more evidence is needed to monitor their effectiveness and inform future decisions.

Left
Woody debris dam installed as part of the 'Slowing the Flow' initiative near Pickering, North Yorkshire.

Being resilient to extreme weather requires more than just a degree of protection from specific hazards. Other steps are necessary to allow individuals and societies to adapt, progress and develop regardless of extreme weather. These steps need to be taken at local, national and international levels and by the public and private sectors, local communities and non-governmental organisations.

Governments should develop and implement resilience strategies and incorporate resilience-building into other policies. These should then be evaluated and updated in the light of new evidence.

If international organisations and national governments direct more funds to resilience-building, the need for costly disaster responses will be reduced. Internationally agreed metrics based on 'inputs' to resilience-building such as the proportion of the population with access to emergency shelters or proportion of the coast with intact coral reefs would help highlight where greater preventative expenditure is needed. Integrating resilience into the global financial system by requiring organisations to report their exposure to extreme weather would incentivise action to reduce that exposure.

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Right
Volunteers plant vegetation on the sand dunes of Seaside Park, New Jersey following Hurricane Sandy.

How?

All these actions need to be informed by the best available evidence.

Involving the users of research, such as policymakers and practitioners, in its production will increase its usefulness. Research funders should encourage this collaboration.

In 2015 important international agreements will be reached on disaster risk reduction, sustainable development and climate change. These agreements will be much more effective in addressing extreme weather and its impacts if their purpose, design and implementation is aligned, and if they are informed by robust evidence. Our report will help those negotiating and implementing the new agreements to decide what action to take to most effectively build resilience.

Download the full report at **royalsociety.org/resilience**

Right
Residents undertake a community resource mapping exercise near Kabale, Uganda.

Recommendations

Planning and preparing

RECOMMENDATION 1

Governments have a responsibility to develop and resource resilience strategies, and will be most effective when they:

- focus on minimising the consequences of infrastructure failure rather than avoiding failure completely - for example by prioritising the resilience of critical infrastructure and having plans to minimise impacts when non-critical infrastructure fails;
- incorporate resilience-building into other relevant policies such as poverty alleviation and land-use planning;
- consider all the factors – the whole system – likely to be impacted by extreme weather, including geographical areas beyond those directly affected, and effects over decades;
- use a range of expertise from disciplines such as environmental management, climate change adaptation, disaster risk reduction and sustainable development, and from sources including the private sector, non-governmental organisations and local communities; and
- support and enable local action that is consistent with national resilience strategies.

RECOMMENDATION 2

At the international level, governments will be more effective when they act together to build resilience; sharing expertise, co-ordinating policy and pooling resources to confront common risks. To limit the need for costly disaster responses, more national and international funds will need to be directed to measures that build resilience to extreme weather.

RECOMMENDATION 3

It is important that the purpose, design and implementation of policy frameworks covering climate change, disaster risk reduction and development are aligned and consistent regarding extreme weather. There is an opportunity to do this in 2015 at the international level. In particular, efforts should be made to:

- emphasise the importance of the natural environment in the successor to the Hyogo Framework for Action, Sustainable Development Goals and future climate agreement – for example by highlighting its role in building resilience rather than just its role in driving risk;
- develop and use identical or comparable metrics in these policy frameworks to incentivise co-ordinated action and allow the effectiveness of different resilience-building measures to be compared;
- measure progress in implementing resilience-building strategies ('input' metrics) as well as the impacts of extreme weather ('outcome' metrics);
- align the timeframes and reporting protocols for the successor to the Hyogo Framework for Action and Sustainable Development Goals; and
- ensure international oversight to strengthen national and local monitoring capacity, particularly in the developing world, and to co-ordinate data collection.

Protecting people and their assets

RECOMMENDATION 4

Extreme weather events are hard to anticipate and their impacts can affect societies in unexpected ways. Those who make and implement policies need to take practical measures to protect people and their assets from extreme weather. These will be most effective when they:

- address multiple hazards and use a portfolio of defensive options;
- consider defensive options beyond traditional engineering approaches – for example, ecosystem-based and hybrid approaches that offer additional benefits to people – and consider the value of conserving existing natural ecosystems that are difficult or impossible to restore; and
- monitor and evaluate the effectiveness of interventions, in particular of more novel approaches such as ecosystem-based ones, and apply the results to improve future decision-making.

Making decisions based on evidence

RECOMMENDATION 5

The re/insurance sector has made considerable progress in evaluating the risks posed by extreme weather. These risks now need to be better accounted for in the wider financial system, in order to inform valuations and investment decisions and to incentivise organisations to reduce their exposure. This could be done through a requirement for public and private sector organisations to report their financial exposure to extreme weather at a minimum of 1 in 100 (1%) per year risk levels.

RECOMMENDATION 6

Information about extreme weather should be suitable for users' needs. Involving those who make and implement policy in research is an important way of ensuring the usefulness of information produced. Funders should encourage collaborations and ongoing dialogue between producers and users of knowledge.

RECOMMENDATION 7

Research to improve the understanding of risks from current weather and to model accurately future climate change impacts should be increased to provide relevant information for decision-makers, particularly at regional and local levels. In particular, efforts should be increased to:

- improve systematic observations and analyses in all regions of the world for trends in extreme weather and its impacts;
- expand interdisciplinary research to understand fully how people are affected by extremes;
- improve international collaborations between climate research institutes, which would allow optimum use of resources to overcome modelling limitations and improve regional and local models and forecasts; and
- produce appropriate data, models and knowledge that can be shared to inform more complete risk assessments for extreme weather.

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