

Royal Society submission to the UK Department for International Development's consultation on its Research Strategy 2008- 2013

This submission is separated into two sections; first it provides recommendations on science, engineering, technology and innovation (SET&I) capacity building and then it addresses specific scientific questions posed in the consultation¹.

Science, engineering, technology and innovation (SET&I) capacity building

1. Science, engineering, technology and innovation (SET&I) play an essential role in development and poverty alleviation. This is recognised in the 2005 statement on Science and Technology for African Development by the national science academies of the G8 nations and the Network of African Science Academies (NASAC). The UK's Department for International Development (DFID) should reinforce this message to key policy makers in both the UK and developing countries and also ensure that its research strategy for 2008-2013 strongly reflects this fact.
2. For SET&I solutions to be used effectively for development, scientists from developing countries must be involved in identifying and tackling the problems that affect them and their communities. Making the best use of local scientists and facilities in the design and implementation of programme work builds capacity and ensures sustainability.
3. In order to ensure the development of well-trained and knowledgeable people, including scientists and engineers, universities and higher education institutes in developing countries need to be the focus of greater development efforts. We recommend that DFID take a more holistic view and look at tertiary as well as primary and secondary education. We welcome DFID's efforts to date, but believe that they could do more.
4. In order to ensure that scientists in developing countries can fully and effectively partake in research programmes they should be given the opportunity to benefit from further training. Such training should ideally take place in the developing country. Instruction on how to use new laboratory equipment and write up results more effectively may be useful. In addition, scientists may also gain from courses on effectively communicating their work, management, leadership and mentoring skills and how to write successful grant proposals.
5. The building of the skill bases in developing countries and in-country expertise is being negatively impacted by the phenomenon of brain drain. The long-term migration of academics and professionals to the developed world may have a particularly damaging effect on the economic well-being of developing countries because academic labour plays a key role in high-level research, innovation resulting in exploitable products and ideas

¹ Q1, 2, 4 and 5

and the development of a new generation of skilled professionals. Brain drain contributes to the widening gap in SET&I capacity between developing and developed countries. DFID should support research into brain drain and look into ways to reduce the negative impacts, such as the provision of in-country training of academics and the improvement of research facilities through capacity building of universities and research institutions.

6. For developing country scientists who return home after receiving training or employment in the developed world, a well thought-out and personalised 'road map' should be implemented for their effective and supported re-integration. One element of such a 'road map' may be mentoring schemes run by their previous supervisors or collaborators from the developed country. DFID could help support initiatives through funding to the developed country research institute.

7. Integral to SET&I capacity building is helping to ensure that research results are communicated and disseminated both effectively and widely. Policy makers in developing countries should be specifically targeted as an audience and the provision of high quality, relevant and articulate advice will allow them to make more considered and informed policy decisions. It can also aid them in international negotiations when discussing issues that may have significant implications for their populations. Examples of such issues include climate change, energy issues and the implementation of emerging technologies. DFID should therefore support initiatives that aim to increase the scientific advisory role of individuals and science organisations such as national science academies.

8. In order to work more effectively, with greater impact, and to maximise use of resources, co-ordination of activities with other donors is essential and requires regular communication. This needs to be done at both a local (regional) and international level. We welcome DFID's initiatives to consult, liaise and partner with other donor organisations and we hope that the UK Collaborative on Development Sciences (UK-CDS) will build on existing coordination. In addition, the Royal Society encourages DFID to further collaborate with the UK research councils and UK learned societies who can contribute expertise on SET&I for development.

9. The Royal Society undertakes wide and varied capacity building work in various ways. We work with several African national science academies to help strengthen their role as science advisors to key decision makers. The Royal Society also runs grant schemes, many of which are open to scientists from the developing world. A good example is the jointly administered Royal Society/National Research Foundation joint collaborative programme, which has helped develop science capacity in some of the most under-funded and disadvantaged universities in South Africa.

Responses to DFID consultation questions 1, 2, 4 and 5

In the following pages we identify areas of research important for development. We are aware of the magnitude of the work and DFID's finite resources. However, we believe that undertaking this work successfully is possible through strategic use of resources and by DFID working in partnership with other donor organisations such as the UK research councils.

1. How can DFID build on its work on sustainable agriculture and develop its work on economic opportunities and growth?

Climate change (adaptation and mitigation)

10. Climate change will impact on agriculture and food security and so must be integrated into research, technology development and management strategies for all agricultural and natural resource management related activities. For further details on integrated approaches towards climate change and food production research see recommendations for future research priorities in 'Food crops in a changing climate: report of a Royal Society discussion meeting held in 2005'.²

11. The strategy for improved sustainability in developing countries should be to focus on developing capacity for dealing with current climate variability. This is a realistic goal and will facilitate the development of the same tools required for dealing with longer term changes.

12. A lot of attention is currently being paid to biofuels and their implications for developing countries in regard to fuel security, environmental impacts and subsequent effects on land use. Further research is required into these issues. The Royal Society is currently in the final phases of completing a policy report on Biofuels.

13. We recommend that DFID fund research into different IPCC emission scenarios to determine the regional and local implications of the scenarios to help inform the development of adaptation strategies to reduce these impacts. Such research must be multidisciplinary and involve marine, terrestrial and freshwater scientists and modellers and include socio-economists with expertise in developing countries.

Atmospheric pollutants

14. More studies of the effects of rising levels of CO₂ and ozone on crops under field conditions are needed; these should be carried out in countries where crop vulnerability is potentially high, and should cover a wide range of major crops. Experimental studies should be used to complement the field research.

Ocean Acidification

15. As detailed in the Royal Society report 'Ocean acidification due to increasing atmospheric carbon dioxide',³ ocean acidification has recently emerged as a serious issue for marine food webs, fisheries and aquaculture. Developing countries dependent on coastal resources are particularly vulnerable to the potential impacts of ocean acidification and DFID should be investing resources in identifying the range of potential impacts to help inform adaptation strategies for these regions.

² <http://www.royalsoc.ac.uk/document.asp?tip=0&id=4790>

³ <http://www.royalsoc.ac.uk/displaypagedoc.asp?id=13539>

Rural sustainability

16. Research is required into the problems facing rural areas, particularly in relation to peasant agriculture, conservation, processing, post harvest losses, marketing, transport infrastructure and consumption. We recommend that DFID develop research proposals that will target rural families and the use of demonstration farms, with a focus on organic mixed farming and appropriate irrigation technologies.

17. Many developing country farmers require assistance with, for example, quality control and the requirements of EU import regulation. DFID support of information dissemination, including market prices for commodities, via the Internet/email or through traditional outreach/extension networks could be useful. Knowledge of markets would provide farmers and other entrepreneurs with the information they require to compete in the marketplace.

Aquatic sustainability

18. DFID must place as much emphasis on aquatic sustainability as land-based agriculture in its research strategy. DFID should investigate ways to reduce the pressures on both inland waters and coastal waters as both are fundamentally important in providing for the health and wellbeing of populations living nearby. DFID should also look at how to provide incentives for local communities to get value out of these resources in a way that does not result in resource deterioration.

19. Many developing countries are dependent on marine and coastal resources. However, marine and coastal ecosystems throughout the world are under increasing pressure from overexploitation, pollution, ocean acidification, and climate change. As a priority, DFID's research strategy must include an integrated research programme that addresses the need to assess the status of the natural resource base for dependent countries and to develop innovative and equitable solutions for management. For example fish stocks are vulnerable to over exploitation because countries often have no means of monitoring or controlling the vessels fishing there. This has had a major effect on the traditional artisanal fisheries that have historically provided an important source of high quality protein. This is a global problem that DFID could help alleviate by undertaking research on the issue and through educational projects to develop state-of-the-art fishery protection practices. DFID could also help conserve and work towards the development of sustainable fisheries and research the future provision of protein from waters surrounding developing countries.

20. Similarly, protection of coral reefs and management of the resources provided by reef systems should be a priority area for research. Coral reefs are critically important for coastal protection, biological production, and the carbon cycle but are now increasingly impacted by pollution, climate change, overexploitation, and ocean acidification.

21. According to the Millennium Ecosystem Assessment 'the global average for nitrogen loading has doubled within the last century making coastal areas the most highly chemically altered ecosystems in the world, with resulting eutrophication that drives coral reef regime shifts and other irreversible changes to coastal ecosystems. Mining and other heavy industries cause heavy metal and other pollution - harmful algal blooms

and other pathogens are on the rise in part because of reduced water quality.' DFID should conduct further research into these issues.

2. How can DFID improve research on "killer diseases" and healthcare and develop its work on building the capabilities of individuals and families for a better life?

Key issues in this area:

22. There are partially effective tools for control of many of the major infectious diseases of the developing world and a major challenge now is to get these used more widely. Health systems research directed at finding optimum ways of increasing use of effective interventions is a high priority.

23. In reference to the need for vaccines, microbicides, drugs and diagnostics for a wide range of tropical diseases, a potential area for research is the distribution of vaccines and drugs produced outside of developing countries. For distribution, there will always be problems until greater parity with developed countries is achieved. Skill centres in vaccine generation may be best developed locally, reducing the cost of production and transferring the technology. This would help increase the science base in the developing country.

24. The focus during the past five years on HIV, malaria and tuberculosis by all the major donors is appropriate but there is now a need to support more research on diseases of the poor outside the 'big three'. For example, pneumonia kills more children than malaria but there has been very little research in this area for many years apart from work, largely funded by the commercial sector, on vaccines.

25. With regard to the recognition that climate change will have impacts on disease burden, more and better monitoring of climate parameters (particularly rainfall, humidity and temperature) is required in order to understand better epidemiological links between climate and major diseases such as malaria and meningitis. This information together with improvements in climate prediction models will allow better forecasting of areas potentially at risk from epidemics under various scenarios.

26. There is a need to support scientific investigation into medicinal plants and other traditional remedies in developing countries. Much of the scientific infrastructure required to do this is lacking in most developing countries.

27. An essential line of research is the multiple stressors affecting vulnerable households, and the implications for institutional responses. For instance, an HIV/AIDS affected household member may be less able to secure food and, conversely, poor nutrition reduces the effectiveness of HIV/AIDS treatments. However, few organisations in rural areas respond to both HIV/AIDS and food insecurity issues. School health is also a relatively neglected area in the developing world that would benefit from more collaboration between educational and health researchers.

Trends most likely to affect this area in the future

28. As recognised by DFID, non-communicable diseases, including mental health, diabetes and obesity are becoming increasingly important in the developing world, especially among the growing middle class, and relatively little high quality work has been done in this area. More research is needed in this field.

29. Health issues affecting the elderly will be an increasing area of concern, as developing countries will find it difficult to cope with their needs.

Key aid effectiveness issues that DFID should consider on this topic

30. As recognised by DFID, tackling the major problems of the developing world requires multidisciplinary research within the health field. The field may need to be cast even further with improved links of health researchers to other disciplines. There has been relatively little collaboration between medical and veterinary scientists and much more could be done in this area, for example on vaccine development (tuberculosis, avian flu etc).

31. Diseases of the developing world will be brought under control only by adopting a wide range of measures and with a broad approach adopted by DFID in its new research strategy. However, within this broad spectrum of research activities, DFID needs to focus on specific areas within each band of the spectrum or else be in danger of developing a research portfolio that is too diffuse.

32. The modest investment that DFID has made in public private partnerships aimed at the development of drugs and vaccines for developing country diseases, such as the contribution of DFID to the Medicines for Malaria Venture (MMV), has been very effective in establishing the credibility of these organisations and in leveraging other funds. DFID should continue to support this kind of activity.

33. Research should be funded into how to efficiently educate people on how to deal with the causes of killer diseases. DFID could support the dissemination of public health messages, based on research, in public and private media in developing countries in partnership with governments.

34. Particular attention needs to be paid to finding ways of reaching the poorest in the community as they are likely to account for an increasing proportion of the burden of infection.

35. Health care in developing countries is facing new challenges from emerging infectious diseases such as bird flu, Ebola and Sars. Epidemics usually spread widely and cause more deaths in most developing countries because the technology for quick identification of the causative agents is not always available. In this respect, DFID's research strategy should include capacity building for diagnosis of epidemics at regional levels in Africa.

4. How can DFID improve research into the impact of climate change on poverty and environmental change more broadly?

36. Climate change is one of many environmental changes brought on by human behaviour. It acts as an additional stressor on top of existing pressures on natural resources, with severe implications for poverty alleviation and sustainable development. In response, there is a great need in developing countries (especially those most vulnerable to climate change) for Research and Development (R&D) into impact mapping and adaptation to climate change.

Monitoring/modelling and adaptation

37. Improving the capacity of developing countries to respond to climate change requires the development of long-term monitoring programmes; research to determine the resilience of different countries to the expected impacts; integrated analysis, which translates the monitoring results into policy and planning options, and technological solutions; and public awareness campaigns to inform populations about the issue.

38. A key gap in the DFID research agenda is support for observation systems both on land and in the sea where key measurements are taken to world standards that can be input in real time to global climate models. Only through the development of a more comprehensive observation system can scientists provide reliable information and advice to policy makers. In particular, permanent and well equipped stations to monitor climate change and the associated consequences are absent in most developing countries. For example; the raingauge network in Africa has declined dramatically since the 1960's. Support for the African National Meteorological Services (NMS's) in increasing their observational networks and investment in satellite-based approaches to rainfall monitoring would help to reverse this decline. Similarly, there are huge gaps in observational networks across the oceans; both in terms of climate monitoring but also in terms of the collection of biological data.

39. The implementation of observation and monitoring networks could also provide an opportunity for involving local communities; for example training residents to monitor changes in crops or fishery resources would help to inform local populations of the climate change issue. It is also vital that developing country scientists are actively involved in projects leading to improvements in both monitoring and modelling. Only in this way can full use be made of local knowledge and in-country data resources.

40. DFID could play a key role in helping to put in place and support over the longer term the infrastructure in selected developing countries for the Global Earth Observation System of Systems (GEOSS). The development of this global observation system will be the focus of the Group on Earth Observations (GEO) Ministerial in South Africa next November. We recommend that DFID is represented at this important meeting.

41. As well as monitoring, the modelling of African rainfall is also important. Simulation of rainfall is one of the least reliable aspects of climate models and this is particularly so for Africa, in part because of the lack of observational data for calibration and verification.

42. A common shortcoming of much of the current research into the impact of climate change on poverty and environmental change is its failure to downscale effectively climate change impacts to a scale (*i.e.*, subnational, catchment, district) and in a timeframe (*i.e.*, the next 5 to 50 years) at which people can use this information constructively. DFID could support climate change research that addresses this oversight.

43. In the absence of accurate predictions (particularly in the immediate future), local populations need access to alternative crops, pesticides and irrigation technology appropriate to extreme climatic conditions and the ensuing environmental changes, which can improve their capability to respond to climate change related risks.

44. Short-term climate prediction in the coming seasons can have an important impact on human health as many diseases *e.g.* malaria, meningitis, cholera, can be climate sensitive. Seasonal to interannual climate prediction is also important in crop prediction and hydrological forecasting. Where local people are involved in measuring and predicting short-term climate variability it will be possible for them to take early measures to prevent famine and other disasters caused by climatic change. See also paragraph 25.

The role of the oceans

45. Most research on climate change in developing countries focuses on terrestrial food production, water availability and temperature changes. The important role that the oceans play in climate change and the downstream effects that they have on adjacent land is poorly recognised as it is a huge and remote environment outside most people's expertise. Human society relies on the oceans as a source for rain, for fisheries and for international maritime trade, all of which are affected by climate change.

46. Changes taking place in the coastal waters of developing countries and further away in the deeper ocean will have an influence over their socio-economic development, with impacts ranging from short-term disasters (such as cyclones/hurricanes and coastal flooding events that may be accentuated by climate change) to changes in decadal-long weather patterns with knock-on consequences for human systems. Part of the DFID research profile should address research on marine processes in coastal developing states that may have a downstream effect on their agriculture and economy. Changes in weather systems such as the monsoons that are closely linked to ocean variability at decadal and longer scales need to be researched as there is clear historical evidence that changes of this nature have had dramatic socioeconomic impacts on past civilisations.

Mitigation

47. There is a need for Research & Development (especially Development) into sustainable energy especially for poor rural communities *e.g.* appropriate applications of solar energy and of energy from biological sources (*e.g.* biogas from waste materials, local biocrops for electricity generation or biofuels). Provision of cheap energy in this way could lead to a dramatic improvement in the economic opportunities of marginalised people and could provide them with a wide range of educational opportunities, for example, through satellite web based communication systems.

Biodiversity – climate interactions

48. The continuing, accelerating loss of biodiversity will compromise the long-term impact of ecosystems on climate change, may accelerate or amplify global warming and could lead to additional, unforeseen and potentially irreversible shifts in the earth system. Urgent action now to halt further loss or degradation of biodiversity will help maintain future options for reducing the extent of climate change and managing its impacts. There are multiple research needs in this area. For refer details we refer DFID to the summary of a recent meeting on Biodiversity and Climate Interactions held at the Royal Society.
<http://www.royalsoc.ac.uk/displaypagedoc.asp?id=27048>.

5. In addition to climate change, what are the emerging global trends that DFID research needs to address?

49. There is a need for integrated research on global trends. While governments are able to look at trends in isolation (e.g. the effects of climate change or energy security on economic development) they often struggle to capture the interdependencies between multiple factors. There is a real need to develop analytical tools and models that can help officials understand the implications of multiple changes to a range of different sectors, covering, for example health, energy, environment, climate change and agriculture. The Royal Society recommends that DFID develops a research unit that can undertake this type of integrated analysis and the implications for poverty alleviation and develop strategic responses. DFID could build on the work of other departments such as the Development Concepts and Doctrine Centre Global Strategic Trends Programme 2007-2036.

Key global trends

For issues relation to ocean acidification and energy see paragraphs 15 and 47 respectively.

Water

50. DFID should conduct research into:

- Integrated water resource management which is increasingly becoming a critical issue, especially taking into account cross-border considerations. Many developing countries lack a detailed understanding of their hydrological status or the drivers of deterioration in their water resources.
- The increased prevalence of intermittent and sustained freshwater scarcity and access to safe water and sanitation in rapidly urbanising areas.
- Sustainable methods of water conservation such as water harvesting and pollution control.
- The regional and global impact of reducing glaciers on the quantity and seasonality of water supply and downstream consequences for agricultural, social and economic development.
- The impacts of sea level rise, especially in low lying countries such as Bangladesh and the need for appropriate world wide warning systems to be put in place for tsunamis.

Food security

51. The ability to produce sufficient food will be impacted by climate changes and increased CO₂ (which has various effects, both positive and negative) at the regional level. Examples of these effects include changing precipitation patterns (e.g. changes in the Indian and African monsoons), increasing sea level rise, storm tracks, and consequently, changes in distribution of pests and crop diseases. The protein sources of many coastal populations are under threat as a result of coral bleaching, sea level rise, coastal inundation, salination, nutrient run-off, climate change, and overharvesting.

52. Conflicts are already apparent in the bioresource economy and food security is becoming more of an issue. One reason for this is the use of fertile land to grow biofuels crops rather than food crops and the redirection of food surpluses, where they exist, into bioenergy. This may result in a decrease in food aid available to developing countries.

53. Other specific areas of research that we recommend DFID undertake include:

- Research on farming systems, particularly emergent farming practices such as urban agriculture, contract farming and use of farm technologies;
- Analysis of how climate change affects resource poor farmers including nomadic pastoralists;
- GMO biosafety and biosecurity;
- Research on indigenous knowledge systems and strategies for coping with environmental change.

54. The food security issue is a sustainability issue that will only be resolved if all of the drivers are addressed together. Research should be focused on identifying what the main drivers are, how they interact and what the implications of these interactions are for the future (including identification of where there may be opportunities to address the combined negative impacts of drivers). The synthesis report of the IAASTD (International Assessment of Agricultural Science and Technology) is scheduled for January 2008 and DFID should review the results of this work when determining what its research priorities in this area should be.

Biodiversity loss

55. This is not a recently emerging issue, but one that we recommend DFID place more of an emphasis on. If biodiversity loss is not halted, as agreed in the EU2010 target, or slowed, as agreed by the Convention on Biological Diversity, then it will not be possible to meet Millennium Development Goal 7 on ensuring environmental sustainability and, in the long term, our ability to meet and maintain the other MDG's will also be compromised.

56. There is a huge need to invest more research resources in the illegal trade of wildlife. In many of the countries in which trade is rife (e.g. Central and North Africa, and South East Asia) there is very little information available regarding which species are present and what their population levels are, which makes it difficult to review trade levels and how much may actually be sustainable. Although DEFRA is the lead UK department on CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora), DFID could play a role in supporting countries in developing their own research networks, data sources, and enforcement/monitoring processes. If DFID were interested in looking into this in more detail the

CITES animals and plants units in the Joint Nature Conservation Committee (JNCC) and Kew respectively could offer research suggestions.

57. Biodiversity loss will reduce the options available for crop alternatives. This is important at the local level, but is also increasingly becoming a global concern.

Health

58. We recommend that DFID conduct research into the impact of the deterioration of natural systems (e.g. reduction in water quality, loss of vegetation cover) on human health. Direct impacts as well as indirect (i.e. the result of increased conflict over scarce resources) should be considered.

59. At the recent Royal Society biodiversity-climate meeting two research priorities that were identified are linking changes in wild species to human health and vector borne diseases. For more information and other recommendations see <http://www.royalsoc.ac.uk/displaypagedoc.asp?id=27048>.

Population growth

60. An area that will emerge of high importance in developing countries over the next decade is adaptive management in mega cities, and urban poverty, spatial planning and the role of public infrastructure more generally. This will affect air quality and consequently human health. Population growth rates will also result in increased demand for food. The body of research to develop sound policy in this area is largely lacking in Africa, and the Asia models may not be simple to translate to new cultures and contexts.

61. Another trend which requires further research is the increase in displaced populations and the role of environmental change in migration.

Air Quality

62. We recommend that DFID invest resources into establishment of research programmes to establish basic research and monitoring programmes on air quality. Ground level ozone has significant environmental, human health, and economic impacts and it is expected that ground level ozone levels are going to worsen under climate change conditions. In many developing countries, where air quality legislation and new technologies have not yet been introduced, ozone levels are already very high. In addition to ozone levels particulate matter is also of concern.

Emerging Technologies

63. As emerging technologies develop there is a need to consider how the benefits of these could be more equitable, and how developing countries can be involved in their development (e.g. standards setting, legal issues, appropriate regulation) so that there are less barriers to their exploitations of these technologies.

64. Science and technology could help achieve sustainable improvements in developing countries, but its use must be accompanied by public and stakeholder engagement so that the public are aware of the risks and benefits associated with SET&I and can influence its development and use.

Please send any comments or enquiries about this response to:

Ms Joanna Sprackett, The Royal Society, 6-9 Carlton House Terrace, London SW1 5AG

Email: joanna.sprackett@royalsoc.ac.uk tel: +44 (0)20 7451 2668 fax: +44 (0)20 7925 2620