



Mid-term Review

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Foresight Project: Flood and Coastal Defence

Foresight, Government Office for Science

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I Executive summary

The Foresight Flood and Coastal Defence project published its final report, Future Flooding, in April 2004. Sponsored by the Department for Environment, Food and Rural Affairs (Defra), the report produced a challenging vision of future flood risks and options for flood risk management and coastal defence throughout the UK over a 30- to 100-year timescale. Its analysis accounted for risks in terms of the social, economic and environmental dimensions of flooding.

This mid-year review (the Review) assesses the impact of the Future Flooding project (the Project) on government, the research community, business, civil society, non-governmental organisations (NGOs), the media and internationally. Three different methods were used to gauge impact: web searches, documentary analysis and a questionnaire survey of key stakeholders.

Achieving and recording impact is an important aspect of all of Foresight's major projects. To this end, Foresight routinely undertakes a mid-term review three to five years after the project has been completed. This Review of the Future Flooding report assesses the impact of the Project some seven years after publication. It was undertaken by Professor Edward Evans of the University of Nottingham and Professor Edmund Penning-Rowsel and of the University of Middlesex (both members of the Lead Expert Group for the Project) and Professor Alistair Borthwick and Dr Myron Van Damme of the University of Oxford. The web searches and the survey of stakeholders were led by Professor Borthwick and his findings are summarised in Annexes A and B.¹

¹ Van Damme and Borthwick (2010) (see Annex A and B for a summary)

2 Overview of impacts

Since its publication, the Project's report has had substantive impact on all the major policy initiatives in UK flood risk management. These include the Draft Flood and Water Management Bill 2009; the Government's 20-year strategy for flood and coastal risk management in England, *Making Space for Water*; the 2007 Pre-Budget Report and Comprehensive Spending Review; and Defra's 2004 five-year strategy, *Delivering the Essentials of Life*. A full list of citations is given in Annex A.

The Project has also had an impact on organisations and agencies at arm's length to central government. For example, it has influenced policies and practices at the Environment Agency. Similarly, in industry, the Association of British Insurers (ABI) has used the Report to develop its own thinking on flooding issues. At an international level, it has been used to inform the European Union Directive on the assessment and management of flood risks, and the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. The report has also influenced flooding management in China's Taipu Basin. Its impact on NGOs and the wider business sector is less clear.

Awareness of the Project has been high. It has received over 80 scientific citations, and received wide media coverage at the time of the launch. It also showed the second highest Google hits of all of Foresight's projects in 2010. In the stakeholder survey undertaken to assess the impact of the Project, respondents noted the Project's significant impact, the importance of its work in changing attitudes and approaches to flooding issues and its positive role in heightening awareness of climate change impacts (see Annex B). Many considered that the Project continued to have value more than six years after publication.

3 Introduction

Foresight was re-cast in 2002 as a programme of in-depth studies examining major issues up to 2050 and beyond. These projects combine the latest scientific and other evidence with futures analysis to tackle complex issues and help policymakers think more systematically about the future. The Foresight Flood and Coastal Defence project (the Project) was published as the Future Flooding report in April 2004.

Achieving impact is an important aspect of all Foresight's major projects. This mid-term review (the Review) captures the impact that the Project has achieved to date and highlights specific successes. It begins by providing an overview of the Project and its main findings. It then sets out a summary of the Project's impact by sector, in particular within government, the academic and research communities, business, the media, non-governmental organisations (NGOs) and internationally. The Review considers awareness of the Project, and highlights stakeholder views about its usefulness and longevity, and its contribution to policy-making.

Impact was assessed using three methods. The first used web searches to explore the penetration of awareness in the scientific, policymaking and public communities. This included a comprehensive web search (Google, Web of Knowledge and Scirus) for citations of 'Future Flooding' in scientific outputs, both in the UK and internationally, and a numerical and textual analysis of the results. The second used documentary analysis to identify the policy documents which have drawn on the Project's outputs. The third method used a questionnaire which surveyed the views of 20 key stakeholders on the impact, merits and demerits of the Project.

4 Project overview

The Foresight Flood and Coastal Defence project produced a long-term vision for the future of flood and coastal defence in the UK. It provided robust analysis to inform policy development whilst taking account of the many uncertainties, such as the future extent of climate change. It considered economic, social and environmental impacts, taking a holistic view of future flood risk.

The Project was initiated by the then Office of Science and Technology project because of growing awareness that flooding poses an increasing threat to the economic and social activity of the UK. The rising values of buildings and their contents means that even the prevailing intensity of flooding could impose greater economic and financial burdens in the future. Climate change will exacerbate the risk still further.

The report sought to answer two key questions:

- How might the risks of flooding and coastal erosion change in the UK over the next 100 years?
- What are the best options for Government and the private sector for responding to the future challenges?

It worked to:

- Identify and assess the relative importance of the threats that need to be taken into account in long-term planning on flood and coastal defence.
- Construct a set of risk-based scenarios taking those factors into account over a 30- to 100-year timescale and addressing social, economic and environmental issues.
- Provide an overview of the responses available and the key issues that determine those responses.
- Inform policy and its delivery.

In doing so, it sought to identify implications for the future skills base, identify knowledge and technologies that might transfer from other sectors and contribute to long-term needs for research on flood and coastal defence. It aimed to inform public understanding and the debate on flood and coastal defence, as well as promote an effective and enduring dialogue among the science base, stakeholders and those with an interest in flood and coastal defence.

5 Key findings of the Future Flooding report

The Project found that nearly two million properties in floodplains along rivers, estuaries and coasts in the UK were potentially at risk of flooding. Of these, 80,000 properties were at risk in towns and cities from flooding caused by heavy downpours which overwhelm urban drains (so-called 'intra-urban' flooding). In 2003–04, flood management cost the UK a total of £800 million, of which £320 million was towards intra-urban flooding alone.

The Project developed four scenarios of the future, based on a scientific review of the main factors which will affect the risks of flooding. These scenarios embodied different amounts of climate change and different socio-economic futures for the UK.

The 2004 report came to the following conclusions:

- Under every scenario, the analysis suggests that if current flood-management policies remain unchanged, the risk of flooding and coastal erosion will increase greatly over the next 30–100 years. Continuing with existing policies is not an option. In virtually every scenario considered, the risks grow to unacceptable levels.
- If flood-management policies and expenditure continued unchanged, annual losses would increase under every scenario by the 2080s. However, the amount of that increase varies, from less than £1 billion to around £27 billion.
- Integrated flood risk management must lie at the core of our response to changes in the drivers of flooding and coastal erosion, combining sensitive engineering with adaptive non-structural measures. The risks need to be tackled across a broad front. Reductions in global greenhouse gas emissions would reduce the risks substantially, but are unlikely to be sufficient. Hard decisions need to be taken: the UK must either invest more in sustainable approaches to flood and coastal management or learn to live with increased flooding.
- Flood management investment would need to rise to an average over the next 50 years of somewhere between £1 billion and £2 billion per annum in real terms for rivers and coasts, and between £400,000 and £800,000 per annum for intra-urban systems to hold flood risk at around its present-day value.
- We have the choice of whether to make the task substantially easier by pursuing mitigation policies that will reduce climate change and flooding through the control of greenhouse gas emissions.
- The mitigation of climate change has, however, little potential to reduce flood risk by the middle of this century, because of time lags within the system. It will become increasingly important towards the end of the current century and when other responses reach their limits. But if it is to deliver its benefits on time, mitigation must start immediately.
- Science and technology have a key role in the development of long-term policies in flood risk management. Integrated responses could reduce the risks of river and coastal flooding from the worst scenario of £20 billion damages per year down to around £2 billion in the 2080s.

- If climate change mitigation were part of the strategy for managing future risk, it would make the task substantially easier.

The Project homepage, including Project outputs, is available at:

<http://www.bis.gov.uk/foresight/our-work/projects/published-projects/flood-and-coastal-defence>

6 Methodology of review

Web-based searches: to assess the penetration of awareness a number of comprehensive web searches were carried out, and both quantitative and qualitative analyses were performed on documents citing the Future Flooding report.

First, the numbers of Google hits were obtained for all documents related to the phrases 'Foresight Future Flooding' and 'Foresight Flood and Coastal Defence' and citations of the Foresight Future Flooding report.

Bibliometric searches were performed using the Web of Science bibliographic database and Scirus, an internet search engine. Web of Science was selected because it covers a very large database of 21,000 peer-reviewed journal titles, 55 million records and about 50 million conference papers. It also provides online citation indices (provided by Thompson Reuters) and impact factors. Scirus was selected as a search engine because of its focus on Science and coverage of a wide range of high quality journals.

The results were compared against the corresponding numbers of citations obtained for other Foresight documents, selected UK government policy documents and international flood and climate change documents. A country-specific Google search collected citations of the Future Flooding report in the G20 countries and in Europe. The Google search was extended to include keywords including 'scenarios', 'sources', 'erosion', 'drivers' and 'emissions'.

After completing the initial quantitative search, the most relevant documents citing the report were divided into international, science-, policy-, non-science- and non-policy-based categories. The science- and policy-based documents were further categorised by means of a series of questions. Subdividing the policy-based documents also helped to assess the significance of the Project on new policy directions. Journal articles that cited the Future Flooding project were also categorised according to the standing and quality of the journal to provide an indirect assessment of the quality of the impact within the scientific community.

The citations were analysed further by a Google search of UK websites using the keywords 'Foresight Future Flooding' and selected science- and policy-related keywords.

The citation search of journal articles using Scirus was based on the keywords 'Foresight Future Flooding'. Citations were then graded in terms of quality using a ratings list developed by the Australian Research Council. The grading showed that the cited publications fall into all categories C to A*, with a significant number published in A and A* journals.

Documentary analysis: the aim of this part of the analysis was to explore further where and how the Project was cited and used. The most relevant documents were selected and allocated to four categories for qualitative analysis (international, science, civil society and policy).

For each document in the science group, the following questions were considered:

- Are the overall findings of the Future Flooding report mentioned in the document, but not discussed further?
- Does the article utilise a methodology from the Future Flooding project?

- Are certain specific results, for instance a graph or a numerical value taken from the Future Flooding report, quoted and discussed within the document?
- Do the documents use the scenario approach in a similar way as that used by the Future Flooding report?

Stakeholder survey: Relevant stakeholders in the Flood and Coastal Erosion Risk Research and Development Programme (FCERM) field, including those in government, in arm's-length agencies and in research organisations (both in the UK and overseas), were sent a questionnaire, each of which was tailored to the role and responsibilities of the recipient. Of a total of 23 questionnaires, 15 were returned. Some responses combined the views of several stakeholders such that the effective response rate was about 75%.

The survey was kept as simple as possible. Question areas were restricted to assessments of:

- the particular strengths of the Project and its results;
- any weaknesses that might have reduced its credibility or inhibited its impact;
- the impact of the Project generally – how far was the Project influential in informing development of flood risk management awareness, policy and practice in the period since 2004;
- whether the results continue to be useful and influential; and
- whether the Project and its results had helped to heighten awareness of climate change.

In addition, stakeholders were asked to cite relevant documents to demonstrate policy or other impacts and to summarise their personal assessment of the Project's impact.

7 Impact by sector

(a) Impact on UK Government departments

The evidence gathered for this Review shows that the Future Flooding Project had a clear impact on, and contribution to, policymaking in a number of government departments in the UK.

Most strikingly, it contributed to the Government increasing its expenditure on flood and coastal erosion risk management by a third. In 2007, HM Treasury directly attributed increased spending in its Pre-Budget Report and Comprehensive Spending Review to the Project's findings:

“the 2004 Foresight Future Flooding report both highlighted that climate change in the UK is likely to increase the severity and the frequency of flooding events. In line with this, total Government expenditure on flood and coastal erosion risk management will rise from £600 million in 2007–2008 to £800 million in 2010–2011.”

The 2007 UK Government strategy for flood and coastal risk management, *Making Space for Water*, addressed the key findings from the Future Flooding Project, used risk values taken from its report and reflected on lessons learned from the flood events in the recent past. It referred to the Project as having “... *highlighted the need for Government to develop a comprehensive, integrated and forward-thinking strategy for managing future flood and coastal risks in England*”. One respondent noted the significance of the mention of Foresight in the fourth line of the ministerial foreword of the consultation for *Making Space for Water*.

The Draft Flood and Water Management Bill 2009 used the Foresight Future Flooding report as a source of background data. It employed the various scenarios considered by the Foresight team to estimate values of the increase in expected flood damage cost per property. In its response to this Review, the Department for the Environment and Rural Affairs (Defra) indicated that the impact of the Project had been “*very high*”, with it having a “*major role*” in the *Making Space for Water* strategy and being “*used in the development of the Flood and Water Management Act*”.

The Department for Communities and Local Government (CLG) also reported that the impact has been “*substantial*”:

“Policy in Defra’s ‘Making Space for Water’ initiative and CLG planning policy for managing flood risk to and from development (PPS25) were directly influenced by the [Foresight] report. The report was very important in providing the justification for, and setting the approach and scope of planning policy.”

The Government's 2007 response to the House of Commons Environment, Food and Rural Affairs Committee's report on the Environment Agency commended the Report:

"We warmly welcome Foresight report's approach to examining long term flood risk and congratulate those involved on their work... The Government's Foresight Future Flooding report in 2004 recognised the potential for flood risk to increase as a result of climate change and sea level rise and also the increased value of assets at risk."

The Pitt Review of the lessons learned from the summer floods of 2007 in England and Wales reports that *"...both the Foresight Future Flooding report (2004) and the Stern Review (2006) have been internationally recognised as credible studies looking into climate change"*.

The Project also had an impact on arm's-length agencies. The Chair of the Environment Agency in 2004, Sir John Harman, reports that the Project formed an important part of the evidence which informed how the agency developed flood risk management awareness, policy and practice in the period since 2004. He suggested that it had created a significant step change in flood risk management. Without this, *"the internal changes that had been taking place within the business (i.e. in the Environment Agency) would have taken much longer to emerge as changes in practice – and some, such as [coastal] realignment – would probably have proved to be wholly unacceptable to Government"*.

The Environment Agency's Long Term Investment Strategy (LTIS) adopted the risk-based approach that was central to the Project:

"[the Project] developed understanding on the investment need[ed] to rise to some of those future risks. It fundamentally changed the approach taken by the Environment Agency and Defra in the analysis of budget need and provided a much needed and reliable evidence base for future budget planning and the development of different policy driven approaches to managing flood risk."

In the devolved administrations, respondents highlighted the Project as of *"fundamental importance"* and that it has been used *"as the touchstone"* for flood risk management in Northern Ireland. In Wales, respondents suggested that it provided the evidence for and has driven the need to change their approach to flood and coastal risk, and *"has been extremely influential"*.

Natural England indicated that *"the Foresight report has been considered in the development of our own approach to flood and erosion risk management"*. However, it noted some disappointment regarding the handling of environmental matters in the Project's work.

The Project has had an impact on the following major policy documents, which represent the core of the major policy innovations in UK flood risk management of the last decade.

- The Draft Flood and Water Management Bill (2009)
- Flood Management Policy Review; Living with Rivers and the Sea, Northern Ireland Rivers Agency (2008)
- The UK Government's water strategy for England (2008)

- The Government's response to the Environmental Food and Rural Affairs Committee's report on the Environment Agency (2007)
- Pre-Budget Report and Comprehensive Spending review, HM Treasury (2007)
- Environment Strategy (2006) and New Approaches Programme (2007), Welsh Assembly Government
- Pitt Review of the lessons learned from the summer floods of 2007 in England and Wales (2007)
- The Economics of Climate Change, Stern Review (2006)
- *Making Space for Water*, Government strategy for flood and coastal risk management in England (2004)
- *Delivering the Essentials of Life* – five-year strategy plan, Defra (2004)

(b) Impact on research community

The results of the Future Flooding report have been frequently mentioned and discussed in the scientific literature. The report has been cited 80 times in a range of scientific journals and reports. Several refer to its scenarios, and many use the report to illustrate the step change that has since taken place in the approach to flood risk management by the UK Government.

For example, the Flood Risk Management Research Consortium programme is a major UK research programme designed to increase the nation's ability to manage flood risk. In its 2008 Final Report it states "*The programme of (Flood Risk Management Research Consortium) work has been designed to complement Defra/EA Foresight, UKWIR and Research Council projects on flooding....The research supports the integrated approach to flood risk management recommended by the Foresight Future Flooding report*".²

The journal article citation search using Scirus was based on the keywords 'Foresight Future Flooding'. Citations were graded in terms of quality using a ratings list developed by the Australian Research Council, which peer reviewed 20,712 journals and awarded each an A*, A, B or C classification according to the following criteria.

Citations in Tier A* journals: Typically a Tier A* journal would be one of the best in its field or subfield in which to publish and would typically cover the entire field or subfield. Almost all the papers it publishes will be of a very high quality. These are journals in which most of the work is important (it will really shape the field). Acceptance rates would typically be low and the editorial board would be dominated by field leaders, including many from top institutions.

² The Flood Risk Management Research Consortium (2008)

The Foresight Future Flooding report received one citation in *Trends in Ecology and Evolution*, a Tier A* journal: Watkinson (2006) reviews a book, *Sustainability* by Bryan G. Norton, and reports on his own [Watkinson's] experiences with the UK Government, stating that: "... in relation to the question of future flooding, where the policy document that drew heavily on the Foresight analysis was developed with recursive interactions among a range of stakeholder groups including scientists, practitioners and policy makers. Moreover the report was produced with the help of non-specialists, so that the language used was relatively jargon free."

Citations in Tier A journals: The majority of papers in a Tier A journal will be of very high quality. Publishing in a Tier A journal would enhance the author's standing, showing that he or she has real engagement with the global research community and that he or she has something to say about problems of some significance. Typical characteristics of a Tier A journal are low acceptance rates and an editorial board which includes a reasonable proportion of well-known researchers from top institutions.

Reference was made to the Foresight Future Flooding report in four Tier A journals:

- *Marine Policy*, one citation: O'Connor et al (2006) refer to the Foresight Future Flooding report when mentioning that "... at least £10 billion of assets are at risk from coastal erosion".
- *Global Environmental Change*, two citations: In reporting on the re-orientation of the UK Government's coastal strategy, Turner et al (2007) refer to Foresight Future Flooding when stating: "...greater stakeholder inclusion and participation is the avowed aim".

Penning-Rowsell et al (2006) report that "...evidence suggests that UK Flooding may become markedly worse as a result of climate and social change". Penning-Rowsell et al also refer to the Foresight Future Flooding report when discussing an approach to flood risk management.

- *Journal of Hazardous Materials*, one citation: Ball and Boehmer-Christiansen (2007) refer to the Foresight Future Flooding report, mentioning that "... there has been a gradual shift in preferences over the years from hard, engineered defences to use of soft, more natural defences".
- *Philosophical Transactions of the Royal Society A. Mathematical, Physical and Engineering Sciences*, three citations: Woodworth (2006) states that "... it is impossible at present to use AOGCM results in assessing coastal impacts or changes in flood risk, other than using their findings as limits on the range of possible scenarios for impact studies such as those in the UK Foresight programme".

In referring to the Foresight Future Flooding report, Nicholls and Tol (2006) state: "...decisions on which areas to protect have been found to be scale dependent". Nicholls and Tol also comment with reference to Foresight Future Flooding in the context of sea-level rise adaptation options as follows "...coastal management will exploit this wide range of options across a range of scales below those involved in this analysis and this requires more detailed assessment".

- McRobie et al (2005) refer to the Foresight Future Flooding report when reporting on the cost of flood countermeasures for the UK. They state that: “...£22–£75 billion of new engineering works will be required by 2080 to implement a portfolio of responses to managing river and coastal flood risk in the UK, with an annual expenditure of £700 million to £1.1 billion compared with approximately £500 million at the present time”.

Citations in Tier B journals: Tier B covers journals with a solid, though not outstanding, reputation. Generally, in a Tier B journal, one would expect only a few papers of very high quality. They are often important outlets for the work of PhD students and early career researchers. Typical characteristics are regional journals with high acceptance rates and editorial boards that have few leading researchers from top international institutions.

Four Tier B journals referred to the Foresight Future Flooding report:

- *Journal of Environmental Management*, one citation (Tompkins et al, 2008): This citation from *Journal of Environmental Management* relates to Foresight Future Flooding Scientific summary, volumes 1 and 2, which are used in combination with several other studies to describe “*the unique pressures from climate change on the two United Kingdom case study cities*”.
- *Catena*, one citation (Sear and Arnell, 2006): Sear and Arnell state the following: “*In the UK, The Foresight Report on Flooding 2004 concludes that current approaches to flood risk management are unsustainable across all types of society from consumerists to participatory. It points towards the need for integrated land and water management to reduce flood risk*”.
- *Geoforum*, one citation (Cooper and McKenna, 2008): Cooper and McKenna cite the Foresight Future Flooding when stating that: “... *at least £10 billion of assets are at risk from coastal erosion*”.
- *Land Use Policy*, four citations: Hadley (2009) cites the Foresight Future Flooding report, noting that “...*28 per cent of the coastline of England and Wales is currently undergoing erosion rates greater than 10cm per year*”.

Wheater and Evans (2009) describe the aim of Foresight Future Flooding, the composition of the flooding system, the four combinations of scenarios and how the data were presented. The article also states: “*It should of course be borne in mind that UK government expenditure on flood risk management has increased considerably since the publication of the Future Flooding report in 2004, thereby reducing the growth of future risk under the ‘business as usual’ scenario*”.

Reed et al (2009) describe the increase in problems in water availability with climate change and discuss management solutions that should be taken. Reed et al refer to the Foresight Future Flooding report in relation to the following statement: “*Appropriate upland management serves to attenuate peak river flows and maintain supplies to lowland areas under low flow conditions. This is likely to become an increasingly valuable service in the future with climate change*”.

Milligan et al (2009) refer to the increase in costs of flood and erosion risk management mentioned by the Foresight Future Flooding reports.

Citations in Tier C journals: Tier C includes quality, peer-reviewed journals that do not meet the criteria of the higher tiers. One Tier C journal referred to the Foresight Future Flooding report with one citation. *Public Health* (Fewtrell and Kay, 2008) refers to the Foresight Future Flooding Scientific summary, volumes 1 and 2: “*Research into the health effects associated with flooding and the number of health reviews conducted seems to have increased relatively recently, perhaps driven by the increase in flooding seen during the 20th Century and the forecast from climate change modelling that this trend will continue*”.

In another example, a paper from the Tyndall Centre for Climate Change Research describes the Future Flooding project as providing an example of the proactive approach taken by the UK Government in flood risk management (O’Riordan et al, 2006). In another publication, the UK AUDACIOUS project (Adaptable Urban Drainage Addressing Change in Intensity, Occurrence and Uncertainty of Stormwater) adopts the definitions provided by the Project (Ashley et al, 2008). An example of the use of data from the report in a scientific paper is “Scenario-Based stakeholder engagement: Incorporating stakeholders’ preferences into coastal planning for climate change” (Tompkins et al, 2008).

(c) Impact on business

The Project had a limited but focused impact, most clearly on the insurance industry. The Association of British Insurers (ABI) reported that “*the findings have been informing our work on flood risk management and the discussions with government around the provision of flood insurance and investment levels as part of the Statement of Principles agreement*”. In its feedback on the Project, the ABI also stated that the Project continued to provide context to their discussions with government. However, as it was the only business organisation that responded to the request for feedback on the report, it is difficult to judge the full extent of the impact that the Project has had on business.

(d) Impacts on the media, civil society and NGOs

In the six years since the publication of the Future Flooding Report there have been 28 references to the Project in UK national newspapers. It has had a less clear impact on NGOs and civil society. References by NGOs are rare, particularly as few focus on flooding. In an isolated example, the Project is cited by the Chartered Institute of Environmental Health.³

³ Chartered Institute of Environmental Health (<http://www.cieh.org>)

(e) International impact

The Project has had significant international impact, particularly in the EU, China, Germany and the Netherlands. Of the 1040 hits for the key phrase 'Future Flooding', 400 were from outside the UK, covering a wide range of countries. The work was carried out using Google for a general reference search, Web of Science for a more focused reference search within scientific documents including conference proceedings and Scirus for references within scientific journals (see Annex A).

In the EU, the work has been credited as demonstrating to the Commission (DG Environment) that "*the UK approach was at the front of the European practice*", and influencing the Commission's agreements with Member States about the viability of basin-scale risk assessments. The Project is cited in the EU Directive 2007/60/EC on the assessment and management of flood risks.

The major EU-funded FLOODsite project 2004–09⁴ recognised the value of the analysis from Foresight. A FLOODsite report on a decision-support methodology (Report T18-09-02) indicated that the work reported:

"builds on existing best practice as developed in other recent projects, includingthe Foresight Futures Project which produced a challenging and long-term (30–100 years) vision for the future of flood and coastal defence in the whole of the UK that takes account of the many uncertainties, is robust, and can be used as a basis to inform policy and its delivery."

The wide international impact of Future Flooding is demonstrated by the following citation in the International Panel on Climate Change (IPCC) technical paper VI, which uses the Future Flooding report to support the statement that "*... the overall cost of flood damage would double by 2100, relative to what might be expected if there was no climate change*". The Report is also cited in the IPCC's Fourth Assessment Report on Climate Change 2007.

The Chinese Taihu project is a clear example in which the Foresight Project has had significant impact. This UK–China cooperation project adapted the Future Flooding methodology to Chinese conditions and culture to evaluate the current and future flood risk for the Taihu Basin, one of the most important regions of China in which Shanghai and a number of other major cities are located, during the next 50 years. In China the Taihu Basin Authority and IWHR, the leading Chinese institute for water resources research, found the Project of great value in introducing new thinking.⁶ They have subsequently applied for a substantial research grant to continue developing the methods for use in China.

The Project is cited in a range of international academic conference papers. For example, the Netherlands Centre for River Studies has used the Future Flooding project for comparative purposes in a report of a special session on 'River Flood Risk Management'. It discusses the approach taken by the Project and compares this with others used in different parts of the world.⁷ A conference paper by Raadgever and Becker mentions use of the Future Flooding scenarios for a case study of the Rhine basin.⁸ In the 2009 Delta Forum International, Deltares

⁴ Samuels (2009)

⁶ See Annex B

⁷ Samuels et al. (2006)

⁸ Raadgever and Becker (2008)

(an independent institute for applied research in the field of water, subsurface and infrastructure) cites the Future Flooding Project as a means of identifying potential increases in flood risk. It noted that the Foresight Project found that flood risk in the UK in 2080 could be approximately 20 times the value calculated for 2004.^{9,10} In another example, an article in the Dutch *Terra et Aqua* magazine, published for the International Association of Dredging Companies, provides an overview of the contents of the book *Future Flooding and Coastal Risks*¹¹ together with a summary of the conclusions of the Future Flooding report.¹²

Table 1 displays the results obtained for G20 countries for which the search recorded at least one hit on Google country sites, along with results for all European countries with a coastline for which the search recorded at least one hit. A score of 10% corresponds to 16 web hits. The top five countries in terms of hits were the USA, Germany, the Netherlands, France and Canada. The total number of hits outside the UK was 400. By extending the Google search to include scientific keywords in addition to ‘Foresight Future Flooding’ the keywords ‘scenarios’, ‘sources’, ‘erosion’, ‘drivers’ and ‘emissions’ were the most popular of the keywords selected.

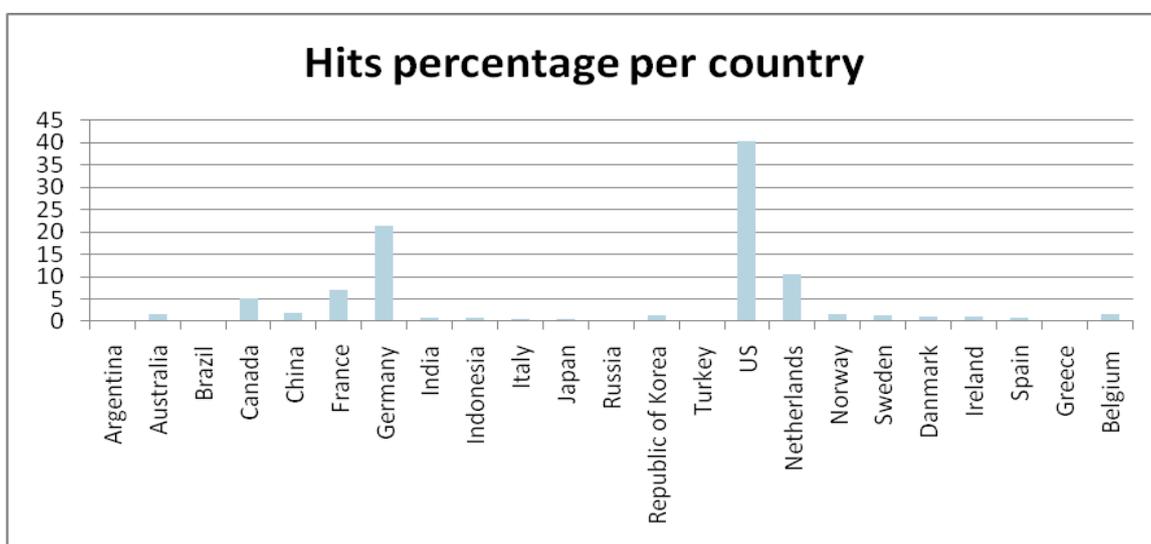


Table 1: Percentage of Google hits on the keywords ‘Future Flooding’ within web pages by country (2010).

Heightening awareness of climate change

There was a slightly mixed response as to whether the Project had heightened awareness of climate change. This topic received the most unanimous positive support, with eight ‘yes’ answers to this question. Many comments added that ‘reality’ was a theme: *“I think it also raised climate change awareness generally because it made the impacts much more real”*.¹³ In Northern Ireland the answer was *“Most definitely, for example, Rivers Agency advised the Planning Service for NI of the intention to flood map at Strategic level with allowance for climate change[;] they were quick to adopt this as their basis for consideration of planning issues”*.

⁹ Deltares (2009)

¹⁰ Merz et al. (2010)

¹¹ Thorne et al. (2007)

¹² Cohen (2007)

¹³ Environment Agency – Harman (see Annex B)

However, the Met Office saw “no evidence of significant effect” in the scientific community. Another respondent added a cautious note:

“Yes, the project has heightened awareness of climate change in that it’s provided details of the scale of future flood risk and particularly on the way in which this might develop in the future as well as the impact of different future scenarios. However...the Foresight report is locked into a series of other major Government and EA strategies, policy and practice documents all of which are responses to climate change so it’s not easy to say that Foresight was specifically responsible for this or that heightened awareness of climate change.”¹⁴

The continued use and influence of the results

In general, the Project’s impact is still considered relevant today, with some exceptions.

For example, the UK Department of Communities and Local Government (CLG) considered that the Project “*has had ongoing value in justifying the planning policy approach to managing flood risk, which was endorsed by the Stern Review and Barker [Report]*”. The Environment Agency considered the Project still to have impact in 2007 and 2008: “*the update of the qualitative part (in 2008) ... was very helpful ... in providing a reality check after a major event (the summer 2007 floods)*”. In Wales, the Project “*...will continue to be the main driver for our change of policy*”. Defra reported that although Ministers have changed, the Project continues to have impact:

“Ministers have moved on since then, however it is still influencing policy and having an impact. It has been (is) very influential on policy and funding decisions. It was used in the last Spending Review (checks were done to see if the investment was consistent with Foresight) and the Long Term Investment Strategy”.

In terms of the Future Flooding methodology, the response here was favourable from members of the Adaptation Sub-Committee of the Committee on Climate Change:

“The Foresight Future Flooding project is one of the studies that has been particularly influential, both in the CCRA (Climate Change Risk Assessment) Scoping Study and in the development of the methodology for the CCRA itself. Thanks to Foresight, flooding stands out as one of the few areas where reasonably high resolution national-scale risk assessment is feasible. Other dimensions of climate risk will not be dealt with at the same resolution in this cycle of the CCRA. In methodological terms the influence of Foresight on the CCRA process (which is to be repeated every five years henceforth) will be lasting”.

The Project’s analysis was updated in the course of the Pitt Review of the 2007 floods in England, which reached much the same conclusions.

¹⁴ Dr Bramley (see Annex B)

There are some exceptions, however. For instance, the Met Office reported that the Project was “*not directly*” useful to the Hadley Centre. Others highlighted that the Project has been used in more limited ways and its impact was affected by the changing economic situation and government funding cuts:

“Foresight is quoted more by way of providing ‘authority’ as distinct from being used as a more detailed platform for developing future policy response. Importantly, its recommendations for funding have not been adhered to in the recent funding cuts, however I can’t say how useful it might have been in reducing the extent of cuts!”¹⁵

Perceived strengths of the Project

Respondents reported significant strengths of the Project. A range of correspondents mentioned the long-term nature of the time horizon used and the long ‘vision’ of the research. The study was seen as comprehensive and integrated and was commended for its systems approach. The results were seen as “*robust, objective, extensive and scientific*”.¹⁶ The inclusion of social, environmental and governance issues was also commended, “*as opposed to the traditional hydro-technical ‘flood defence’ type of assessment*”.¹⁷

The Chairman of the Environment Agency at the time of the Project’s launch, Sir John Harman, noted the successes of the Project:

“At the outset I was worried that the exercise would be either too academic or too mandarin or both, but it avoided those failings. I have no real criticisms – any subsequent failings were down to how the report was taken forward, and they were few. Its impact would have been smaller without the commitment shown by Sir David King, whose initial scepticism on the subject soon became missionary zeal.”

Many respondents commented on the quality and diversity of the scientific team that produced the report, the professionalism of its management and the commitment of those with oversight responsibilities. The Project was seen as disciplined in the timescale to which it kept, and respondents mentioned that the resources deployed were “*very reasonable*” for the scope of the work at a national scale. The independence of the work from government was cited as an important strength by the ABI and Defra.

The report and its research were praised for its understanding of the science/policy interface. One comment was the “*unique link*” here between policy and science, whereas “*all too frequently in the UK there has been poor involvement and buy-in of key stakeholders and (science) users*”.¹⁸

¹⁵ Dr Bramley (see Annex B)

¹⁶ Welsh Assembly (see Annex B)

¹⁷ Paul Samuels (see Annex B)

¹⁸ Dr Bramley (see Annex B)

Factors limiting impact

Most of the perceived weaknesses were seen to be the size, density and the lack of user-friendliness of the Project's many reports: "*even the Executive Summary was 55 pages long*"¹⁹. This was seen to limit dissemination, and the visibility of the work was not as good as it might have been: "*This meant that the central ideas were disseminated to a limited few*".²⁰ One respondent considered that the target audience was too diffuse, such that some of those who needed to take notice could "*hide*".

*"My personal view is that the complexity and comprehensiveness of the report has made it difficult for the wider business to take ownership of the results. This is all about communications and distilling from the project the simple messages and distributing these across the business."*²¹

Interpretation of the results was seen by some as difficult. Two respondents considered that the close coupling of the socio-economic with the climate change scenarios made this interpretation problematic "*because a number of factors [affecting flood risk] were changed at once*". The different methods used in the analysis of flooding in Scotland and in Northern Ireland, owing to non-comparable property databases, were also seen to make inter-country comparison difficult. In terms of the research reported by the Project, two respondents considered the evidence base for the erosion predictions to be sparse, and the treatment of the intra-urban flooding was seen as "*somewhat cursory*"²² and "*understandably weak*".²³

Several respondents to the stakeholder questionnaire questioned whether the Project's conclusions were resilient to the changing economic climate. One respondent considered that "*the handling of environmental issues was superficial*"²⁴ and criticised the report for implying that "*we will be able [to] engineer our way out of many of the anticipated problems and that this can be funded by increased wealth*", which they saw, in autumn 2010, as "*no longer...a realistic prospect*". Another respondent saw the high growth scenarios as perhaps not credible "*following the recession*".²⁵ One respondent considered that the work had been too costly.²⁶

Some scientists consulted considered that an insufficient range of climate change uncertainties had been examined and that the uncertainties inherent in large-scale risk assessments had not been properly stated.²⁷ Others highlighted that the Future Flooding linear cost model did not indicate how costs for risk mitigation might be phased over time, and that not enough attention was given to resilience rather than flood resistance measures in the treatment of adaptation measures.

¹⁹ ABI (see Annex B)

²⁰ Environment Agency (see Annex B)

²¹ Welsh Assembly (see Annex B)

²² Environment Agency (see Annex B)

²³ ABI (see Annex B)

²⁴ Natural England (see Annex B)

²⁵ Defra (Phippard quote) – see Annex B

²⁶ Defra (see Annex B)

²⁷ Paul Samuels (see Annex B)

8 Final conclusions

This Review highlights that the Project has had a strong and enduring impact since its publication, particularly in influencing UK domestic policy and international work. Domestically, it has contributed to the major policy documents on flooding and has led to a major increase in funding for flooding, although the longevity of this impact is susceptible to the changing economic situation. Internationally, it has influenced policymaking at the EU level and, most notably, in a UK–China collaboration on flooding in the Taihu Basin.

The Review is less clear about the Project's impact on business, and the relatively small NGO sector focused on flooding. Evidence for this is quite sparse, indicating that it has had only limited impact or that it is difficult to find robust evidence to suggest otherwise. Similarly, information about the number of Google hits it has achieved gives an indicative but superficial impression that its influence has been widely dispersed. Analysis of its references in different categories of journals more strongly suggest that it has contributed to a focused, but sufficiently well-regarded, collection of research.

This, combined with stakeholder contributions, demonstrates that the Project continued to be of enduring value in 2011 seven years after its publication.

Annex A

The policy documents identified from both the web and opinion surveys which cite the Future Flooding project are listed below.

- ABI, 2004. A Changing Climate for Insurance. A Summary Report for Chief Executives and Policymakers.
- ABI, 2005. Financial Risks of Climate Change.
- ABI, 2005. Making communities sustainable – managing flood risks in the government’s growth areas.
- Barker Review of Land Use Planning. 2006. HMSO, London.
- Defra, 2004. *Delivering the Essentials of Life*. Defra’s Five Year Strategy.
- Defra, 2005. *Making Space for Water*: Taking forward a new Government strategy for flood and coastal erosion risk management in England: First Government response to the autumn 2004 Making space for water consultation exercise. London.
- Defra, 2009. Draft Flood and Water Management Bill.
- Defra, 2010. UK Climate Change Risk Assessment.
- Defra, 2008. Future water, The Government’s water strategy for England.
- Environment Agency, 2009. Investing for the Future, Flood and coastal risk management in England, A Long Term Investment Strategy.
- Environment Agency, 2010. Future Flooding in Wales: Flood Defences – Possible Long Term Investment Scenarios.
- Environment Agency, 2010. Thames Estuary 2100, Managing Flood Risk through London and the Thames Estuary.
- EU, Directive 2007/60/EC of the European Parliament and of the Council on the Assessment and Management of Flood Risks.
- Hansard, 2006. (HC Deb Vol. 6 Dec 2006 : Column 93WH)
- HM Government, 2010. The UK Flood and Water Management Act 2010.
- HM Treasury, 2007. Pre-Budget Report and Comprehensive Spending Review. Section D12.7, Flood and Coastal erosion Management and Floods Zero baseline review.

- IPCC, 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, et al, Editors. Cambridge University Press.
- Northern Ireland Rivers Agency, Flood Management Policy Review; Living with Rivers and the Sea – Government Response to the Review; Interim Flood Mapping Strategy; Flood Map Methodology Report; NI Sustainable Development Strategy (Chapter 4).
- Pitt, M., 2008. Learning lessons from the 2007 floods, an independent review.
- DCLG, 2007/2010. Planning Policy Statement 25 'Development and flood risk (PPS25) (December 2007, updated March 2010).
- Stern, N., 2007. The Economics of Climate Change: The Stern Review., Cambridge: Cambridge University Press.
- Welsh Government. The Assembly Government's Environment Strategy launched in May 2006, and in its New Approaches Programme launched in summer 2007 and the Assembly Government's National Flood and Coastal Risk Management Strategy to be launched in 2011.

Annex B

Summary statements from key stakeholders

Respondents were asked the question: “How would you summarise – in a phrase or two – your personal assessment of the impact or otherwise of the Project and its results?” This was designed, obviously, to force a succinct judgement. The responses are presented verbatim, as in Table 2 below.

Table 2: Summary judgements; selected quotations from stakeholder replies.

Key stakeholder	Summary statements
Association of British Insurers (ABI)	<p>The Future Flooding report has provided us with the much needed evidence base for developing a holistic long-term flood risk management framework. The good work needs to be continued, especially in the context of surface water flooding.</p> <p>The ABI continues to consider this project as a very important contribution to flood risk management efforts in the UK. We are very keen to see this be good work being continued and we would certainly be prepared to provide our input into any future work in this area.</p>
Adaptation Sub-Committee (drafted by Hall)	<p>The Future Flooding project provided a timely stimulus to development of policy and practice for sustainable flood risk management in the UK. [It] demonstrated how quantified assessment could provide useful evidence about the scale of future climate risks in the UK. This was an important precursor to the UK Climate Change Risk Assessment.</p>
Dr Mervyn Bramley OBE (independent; formerly Research Manager, Environment Agency, and member, Foresight Future Flooding expert advisory group 2003–04)	<p>The results of the Foresight project have underpinned the long-term focus on the nature and management of future flood risk that we now have in the UK.</p>
Department for Communities and Local Government (CLG) – Hackland/Bide	<p>The project had a significant impact on the development of Government policy for flood risk management.</p>
Defra – Hurst (personal view)	<p>A high impact project, which played a major role in changing informed government and public opinion and which undoubtedly led to greater government funding for floods than would otherwise have been the case.</p>

Key stakeholder	Summary statements
Defra – Phippard	<p>Good synthesis of the best available science at the time to produce a credible assessment of the long term challenges in flood and coastal erosion review. It has been very influential in the development of policy and decisions on funding investment.</p>
Environment Agency – Harman	<p>....It served to bring organisation to the existing reservoir of expertise...By presenting the long term economic impacts of changing flood risk in a robust manner, it drew the attention of economic policy makers and thereby made space for other long standing strategic issues such as coastal realignment, land-use practices etc to enter their considerations.</p> <p>It may just be because I was close to the Foresight Flooding work, but my perception was and is that it was one of the most successful and influential Foresight outputs – it certainly had enormous practical impacts, taken in conjunction with other drivers such as the series of severe floods from 1998 onwards and the shift from defence to risk management within the profession.</p>
Environment Agency – Rooke	<p>The project has helped to change the culture from one of reacting to floods to one based on managing risk. It provided a seminal assessment of the future risks and options for long term management of flood risk, vital for supporting policy change in the UK. It also provides an evidence base for the impacts of climate change, and the possible measures needed to combat its effects.</p> <p>Its rich resource could have been better presented in the final reports. There is no meaningful web based material from the project, and if you want to read the report, and you don't have a copy, you need to buy one. All this, and its style and format, meant we suspect that it was not as well read as it could have been by large numbers of people.</p>
Met Office	<p>Little evidence of significant impact. It would be useful if future work could have more “metrics of effectiveness” included at the design stage.</p>
Natural England	<p>The project has had a marked influence on the development of the national approach to flood and erosion risk management over the last 6 years most notably in helping to shape Defra's influential Making Space for Water Strategy. It is disappointing that the Foresight report did not look more seriously at natural environment issues.</p>

Key stakeholder	Summary statements
Northern Ireland Rivers Agency	It created a structure and acted as a catalyst for many of the concepts and issues at the time and brought new ones to light. It introduced the use of scenarios which had not been used previously which dovetailed with the UKCIP approach. It proved very effective in bringing forward Strategic Flood Mapping and the Floods Directive for NI.
Paul Samuels, Technical Director at HR Wallingford Group; Associate Lecturer at The Open University	A comprehensive, integrated review of the flood risk system.
US Army Core of Engineers – Durden	[It] provided [a] clear context and focus for a very challenging and important topic. It is a model for other governments.
Welsh Assembly	This project has driven fundamental change to the way we approach flood and coastal risk in Wales. While the 2007 floods and the subsequent review by Sir Michael Pitt has highlighted the challenges we face and has accelerated the move to a risk management approach, the work undertaken as part of this project very much set the scene and prepared the ground.
Sir David King, Government Chief Scientist (October 2000 to December 2007) and Director of the Foresight Project	There are very few projects of this magnitude in my opinion that have had such a big impact both nationally and internationally.
Professor XT Cheng (IWHR Beijing)	<p>... the project introduced a new concept of Future Flooding from UK to China, and the Taihu Basin is the first one in China who utilized the results of scenario analysis for long term and with multi-disciplines research in making flood management planning ...</p> <p>...Foresight ... not only shows us what will happen in the future, but also what should we do today wisely to ensure the sustainable development in the long term.</p>

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