

DEBATE SUMMARY

The National Flood Resilience Review: the lessons learned from recent flood events in the United Kingdom

Held at The Royal Society on 12th October, 2016.

The Foundation is grateful to Berkshire Hathaway International, Cranfield University, Risk Management Solutions (RMS) and Willis Towers Watson for supporting this debate.

The hash tag for this debate is #fstflood .

Audio files of the speeches are on www.foundation.org.uk .

Chair: **The Earl of Selborne GBE FRS**
Chairman, The Foundation for Science and Technology

Speakers: **Professor Dame Julia Slingo DBE FRS DSc**
Chief Scientist, Met Office
Dr Doug Wilson
Director, Scientific & Evidence Services, Environment Agency
Simon Warsop
Chief Underwriting Officer, Personal lines, Aviva

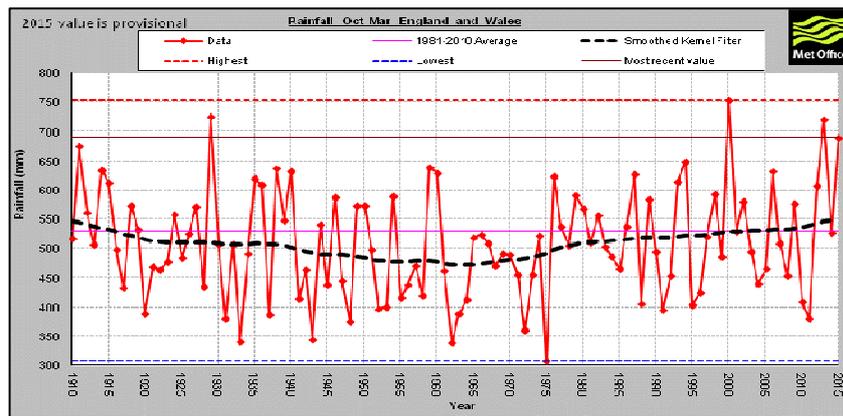
Panellists: **Professor Charles Godfray CBE FRS**
Chair, Defra Science Advisory Council and Hope Professor, University of Oxford

Professor Bas Jonkman
Professor of Integral Hydraulic Engineering, Delft University of Technology

DAME JULIA opened her presentation by showing photographs of floods in the Somerset Levels and at Carlisle to illustrate how disrupting and damaging flood events can be. The Met Office is working hard to improve forecasting, preparedness and the quality of the response after a flood event.

of tonnes of water to the Cumbrian hills. To forecast such events requires a model that incorporate correlations of the weather over the UK with other parts of the globe such as the North Atlantic Oscillation or the Arctic sea ice extent. We do know that there is an expanding envelope of hazard, with warmer, wetter winters and hotter, drier summers.

The intense, localised rainfall observed in December 2015 was a surprise. The inter-annual variability of rainfall over Cumbria has always been high masking any long-term trend caused by climate change. Inter-annual variability will be the dominant factor over the next decades.



Inter-annual volatility of the October to March rainfall in England and Wales

There are many variables that drive the atmospheric and ocean system. The 2015 storm that hit Cumbria was created by a blocking flow which kept part of the jet stream stationary flowing over England – a moist air flow that delivered thousands

be compared to observations over a run of years. Such simulations must sample the same boundary and starting conditions as the real world, yet be able to evolve to different regional and climate regimes. 1,400 simulation runs representative of the period 1980 to 2015 are used to examine the tail behaviour of the system. The Environment Agency uses this

output and other inputs to test the effects of such climatic events, their relationship to river flows, where the water goes for a given terrain height map and the flow patterns created by natural and man-made obstacles or exit routes such as culverts.

From this modelling work we estimate that there is a ten percent risk of extreme rainfall in any one of the six UK regions annually; and one percent risk of exceeding the observed maximum rainfall by 35% in any one of these areas. In a sample stress test in Carlisle the simulated flood area was virtually the same as the observed 2015 flood extent.

An integrated approach to flood modelling, combining global and local weather forecasts, hydrological and impact modelling, and response strategies, including engineering defences and land and water management is required.

DR WILSON agreed with Dame Julia about the impact of the December 2015 storms. There was a national 24 hour rainfall record for Honister Pass, a national 48 hour record for Thirlmere, the wettest month on record and the largest ever recorded flows on English rivers. The stress testing of flood models in Carlisle, Oxford, Exeter, Mytholmroyd, Great Yarmouth, and the Lower Thames showed that the Extreme Flood Outline coincided closely with simulations involving 20% or 30% more rainfall. This work informed an assessment of local infrastructure resilience to see where temporary barriers may be used to increase protection.

A flood event can mean that not only is an area physically isolated but also cause it to be without power or communication, adding to the disruption caused. It is important to protect crucial points in the local infrastructure which, if affected, may impact on many services. The Agency now holds 40 km of temporary barriers ready to respond to flood events. Utility companies are procuring their own temporary barriers too.

Many river gauges in northern England showed that in December, 2015 rivers had the highest river level ever recorded. However, few river gauges have records which go back further than the 1960s, so we do not have earlier records of flood levels. The Agency is seeking photographs, newspaper reports and other accounts of floods to provide evidence of how far flood water in pre-1960s extreme events went. This will enable us to put recent flood events in the wider historical context and improve designs for protecting infrastructure.

It is clear that more needs to be done to improve property level resilience and the Property Flood Resilience Action Plan recently published by Defra is very welcome. The Action Plan recommends that Building Regulations need to be strengthened, certification procedures for resilience measures established and, above all, improved dialogue with the public about flood risks and how to mitigate them.

Floods will happen, and may get more frequent, even if we do not yet know the impact of climate change on the long-term trend. Whatever the government does there is an important role for citizens and communities to be involved in understanding why they must protect themselves and the means for doing so.

SIMON WARSOP agreed with Dr Wilson and Dame Julia. Floods will happen, and extreme weather conditions are likely to become more frequent. Three elements need to be put in place to deal with this - first information on flood risk which is understandable to individuals as well as experts; second, a response by communities so that they act together and people help each other; and third, a long term strategy for pre-flood planning as outlined by Dame Julia.

Although flood modelling is improving, models may not always incorporate local circumstances such as the flooding caused by a blocked culvert at Kendal last year.

New technology can be used to identify blocked drains such as surveillance by drones, but local observations is still vital.

Most people do not cope well with a risk estimate expressed as 1 in 25 and whether it is better or worse than a 1 in 100 risk. Nor do many people accept that they do not need to be next to a watercourse to be flooded. This means that householders do not build in resilience to flooding in their homes, although there is strong evidence simple modifications can work to keep water out and enable a speedy clean up if water does enter a property. But support for preparations for a possible flood could be more effective. There are grants available, but they take some time to come through. Some are available only after flooding has taken place. Examples were given of resilience measures being rejected, and warnings ignored. More needed to be done to make installation of resilience measures more attractive to the homeowner.

Flood Re, the state funded insurance scheme for homes susceptible to flooding, is still too limited. It does not cover commercial property, and is limited to providing cover for houses built before 2008. Insurance covers damage to property but does little to help with the emotional impact that flooding has on householders. There need to be community focused and infrastructure defences to work alongside individual efforts. Future planning for flood risk starts with an understanding of the whole river catchment and forecasting river flows. Buildings should only be built where flood risks are low and can be mitigated. planners should be stricter on allowing modifications to dwellings such as tarmacadamed drives, which increase surface water run-off.

PROFESSOR CHARLES GODFRAY opened the discussion. Social scientists could help in formulating strategies and tactics for communicating

flood risk. There are many publics, some very knowledgeable, some obtuse. Communications should be in terms individuals understand – not talking about a 1 in 25 risk – but how floods affect a householder and how likely is a flood event. Words matter – we should think hard before using words such as ‘unprecedented’, ‘disastrous’ etc. We must promote behavioural change. There may be lessons to be learned from the techniques used by marketing companies.

PROFESSOR BAS JONKMAN explained the position in the Netherlands – 60% of the country was flood prone, with 70% of the population living in the flood prone regions. So flood resilience is a national priority – 900 million euros are committed every year to improving flood defences. National and local institutions were involved in implementing a long-term strategy. We need to ensure cost effectiveness and we are updating our safety standards, in accordance with various scenarios, with new design requirements for temporary and permanent defences set to respond to a 1 in 10,000 return period event.

In the following discussion, participants were concerned that the aim of considering integrated catchment areas did not take full account of local amenities and concerns. For example, afforestation on the fells, to replace sheep farming would reduce peak flows, but would not be ecologically acceptable. But eco-management could be beneficial to peak river flows. Defra’s 25 year management plan would be looking at long term land management issues. Flooding was not the only issue to be considered in land management. There was always the possibility of other climatic events such as drought, or, indeed market changes which rendered some land use uneconomic. With a fully integrated catchment system, climate simulations can be used to explore the effect of different land management systems.

Decision makers who make investment decisions need science based advice to decide what defences – both permanent and temporary – should be procured at the right time in the right place in order to cope with variability, the changing layout of homes and commercial properties and increasing population.

Each flood event gives us new lessons to absorb; we need research on catchment levels, on the interaction of ecological and economic issues, and the link between rainfall and river levels. We need to understand more about infrastructure liabilities – how the damage to one form of infrastructure can affect other utilities. We also need to be more proactive in using technology, such as CCTV, to identify critical flow restrictions in flooded areas.

Communication of risk to the public was seen by participants as being vital but also very difficult. The way risk was communicated in other areas – such as road management – could be explored. Communication to an individual is likely to be effective only if he or she can link the threat to

something personal – such as the length of his or her mortgage.

People often want only to be told what to do, not to make a risk judgement. But a message of what to do is often too late or ignored for other reasons. Real time modelling theoretically would help, but that depends on detailed information which is not always available, and it is difficult to get messages through when in the middle of a flood. IT and mobile phone companies are researching new methods for communicating key information to responders and the general public. Much can be done through community networks, but there is always the question “how can I be sure I am absolutely safe” is often evaded. Local authorities should take more action but both councillors and officials are sometimes ignorant of flood risk or do not want, for political reasons, to highlight this risk.

We need more research on how institutions can work together. We should, for example, think carefully how we are to present the Property Resilience Action Plan to the public. It must, to have effect, be translated into layman’s language open to a wide diversity of readers, but be clear on risk and cost. Who is to do this? In the Netherlands it is the Water Boards – but do we have in the UK an organization with the same reach and authority? After the 2010 Act the County Council and other authorities in Somerset did set up arrangements with a clear definition of respective responsibilities which is effective. But it is not clear nationally where responsibilities lie and whose job it is to do all the various tasks when a flood happens. Everyone in the property business should be required to explain to house buyers the risk posed by flood events – estate agents often down played such risks.

Although the Environment Agency often objected to building on flood plains, it was difficult for planning authorities to refuse permission given the shortage of housing.

It was suggested that references to ‘risk’ was not the good word – a better word could be ‘chance’.

Participants welcomed the Review as it brought together scientists and environmentalists and recognized the need for integrated management and research and investment. But we still need to decide how much the government is willing to invest to limit the damage of flooding. The National Risk Register for Civil Emergencies¹ highlights flooding as a significant threat for the United Kingdom. Costs must be set against the damage that floods cause – damage not only to property but also to public health and well-being. Benefits should include other ecological benefits through reducing flooding, such as reduced soil erosion and protecting the environment. The Report recommended higher standards for infrastructure protection, but it is not

1

www.gov.uk/government/uploads/system/uploads/attachment_data/file/419549/20150331_2015-NRR-WA_Final.pdf

clear how long it will take for these to be in force and whether there will be adequate funding.

The principal points from the discussion were:

1. The importance of communication; and the need to make clear the danger of a flood event to individuals in a way they can buy into.

2. An individual must play a part in protecting herself or himself. This required significant community and institutional support.

3. Flood protection is expensive. Funding needs to be well directed. The ecological benefits go wider than mere flood protection and such benefits should be incorporated in into cost/benefit analyses.

4. It should be much clearer which departments, agencies, regional or local or other authorities have responsibility for preparing for possible flood events and, if they do happen, managing support to householders and business owners and others in response to a flood event.

Sir Geoffrey Chipperfield KCB

Go to the end of this document to see a list of useful URLs. Below is the report of a round-table discussion held in the afternoon before the debate in the evening.

ROUND-TABLE DISCUSSION SUMMARY

The National Flood Resilience Review: the lessons learned from recent flood events in the United Kingdom

Held at The Royal Society on 12th October, 2016.

Chair: **The Earl of Selborne GBE FRS**
Chairman, The Foundation for Science and Technology

Speakers: **Katharine Hammond**
Director, Civil Contingencies Secretariat, Cabinet Office
Professor Bas Jonkman
Professor of Integral Hydraulic Engineering, Delft University of Technology

KATHARINE HAMMOND opened by summarising the recommendations of the National Flood Resilience Review² (NFRR) which had been set up as a result of the significant impact of the storms in December 2015.

After the enormous damage caused by the floods in 2007, significant progress has been made in preparing for future severe flood events: a joint Met Office/Environment Agency Flood Forecasting Centre had been set up, responsibilities within government clarified and other measures taken to embed best practice on recovery from flooding. But the NFRR undertaken by nine Government Departments, the Met Office, Chief Scientific Adviser and Environment Agency aimed to establish why these 'rare' events appeared to be happening with greater frequency; whether we need to do more to protect infrastructure; whether more temporary protection is needed; how to cope with the revised scenarios of heavy rainfall events (and not talk about them happening once in 100

years); and developing standards which will inform resilience in line with events.

The key findings from the review were that we should be careful to be clear when discussing flood risk whether we were focussed on a national or a catchment level risk (as the national risk will be much higher), and that integrating Met Office and Environment Agency flood modelling suggests that a reasonable worst case for planning purposes is the 'Extreme Flood Outline' published by the Environment Agency³. The telecommunications and water industries have voluntarily agreed to review their infrastructure's resilience against a flood that reaches the Extreme Flood Outline and to make temporary improvements by Christmas 2016 and more permanent improvements in the longer term. As a result of the Review, the Environment Agency is also investing in an additional 32 km of temporary flood barriers to be able to respond more flexibly to flood events across the country.

² The National Flood Resilience Review, Cabinet Office
www.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf

³ http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopic&lang=_e

PROFESSOR BAS JONKMAN explained the position in the Netherlands, where flood protection was a national priority, as 70% of the population lived within flood prone areas. Annual costs of 900 million Euros were shared 50/50 between national and local governments. There were 3,800 km of flooding defences, but 30% were not up to standard. A Risk based approach was used to prioritise resources based on economic and life-saving consequences; with a 1 in 10,000 risk to a defence in any one year from a flood event. Standards were recast to achieve this. Risk reduction interventions involved reinforcement of defences; system studies of rivers, and innovations to build defences with nature. There was now a good understanding of roles and responsibilities, continual funding, sophisticated risk assessment leading to better investment and the use of both permanent and temporary defences.

Also in September Defra has published the Property Flood Resilience Action Plan which had concluded that there should be a revision of the Building Regulations, flood protection measures, flood relief and revision of insurance policy wordings. Government and the insurance industry need to agree whether an insurance policy exists to restore a property or the insurance claim can be used to incorporate resilience to future flooding events (the problem of betterment); the need for a one stop shop so people knew where to go for advice; and the need for individuals, communities and authorities to work together.

The following points were raised in discussion:

1. In Cumbria, politicians wanted better weather warnings and more accurate forecasting.
2. The Research Councils and the Environment Agency are working with the Met Office to improve forecasting and analyse the effect of climate change; but this is a five year research programme.
3. Steady investment year on year is essential. Investment should not depend on warnings of possible disasters but follow a consistent strategy based on risk assessments.
4. There were concerns about the methodology underlying estimates of probability. We must go beyond probability to deal with the havoc of storms, as companies do when considering catastrophic reputational claims. But the Government is not a private company; it is spending taxpayers money. The National Flood Resilience Review did work on the basis of probability. But relative probability based on observation may not be adequate as the number of years in the observation time series is only from the 1960s.
5. It is not just immediate rainfall that causes flooding; if the ground is saturated river flow will increase. This was key factor in the floods in

Cumbria. Heavy rain fell over many days saturating the soil and increasing run-off.

6. Are we looking at the probability of aggregate events or the size of a single loss? Although there is no evidence that flooding is getting worse, losses are increasing as population increases and property values rise.

7. The National Flood Resilience Review considered the likelihood of changes in the current climate. Inter-annual variability will mask possible climate change impacts over the next decades.

8. Was sufficient work being done on innovative designs for temporary protection? Such work was going on, and it was important to know when deployment of temporary defences is more cost effective than permanent protection.

Considerable research into innovative temporary defences was taking place in the Netherlands. It was not only their reliability that was important, but also that they were effective in cost/benefit terms.

9. Cost benefit analysis was challenging. The cost of defences could be estimated but not necessarily the benefits - which could be much wider in ecological terms than damage from a flood event. What is the benefit of saving a house in a flooded area, when it would be possible to evacuate the area? Can you count having a better life when the threat of flood is removed as a benefit?

10. Better communication is essential. People don't understand risk or flood warnings. It is vital to involve communities in explaining what they mean.

11. Has sufficient thought been given to land management? This ranged from local incidents, such as a train crash caused by a landslide generated by water moving from fields into an embankment, to turning areas of farmland into wet land. Management is important but detailed supervision must be avoided..

12. Would the flood resilience measures be effective if there were other "perturbations" which might affect property? This would affect the cost/benefit ratio.

13. When an area is flooded, services don't matter, as people must be evacuated, but the question is, where to? Many people would prefer to stay in a flooded home than move.

14. More thought needs to be given to flooding from storm surges combined with high tides. Coastal flooding can be widespread affecting large numbers of people. Flooding of ports could lead to challenging supply problems.

15. The Environment Agency gives priority to saving lives and protecting domestic property. The challenge is how to prioritise the available

investment funds.

16. There are many organisations both public and private who have an interest in flooding for example local authorities; water boards, utility companies, and the devolved administrations. We need to be clear what their responsibilities are, for a wide range of flood scenarios.

17. The Department of Transport is evaluating the threat to 1,400 bridges that are vulnerable to flood damage which are important to prevent communities being isolated, but also bridges whose loss could cause interruption to power distribution or interference with key communication cables.

In summing up PROFESSOR JONKMAN said (a) there must be a balance between what the state

can do, and what a community or private person must do to protect her of himself; (b) a risk model is the key to prioritisation but it is important to understand correlations; (c) it must be clear who takes the lead in pre-flood planning, and post-flood recovery; and coastal surges needed to be considered in relation to critical infrastructure and economic effects.

KATHARINE HAMMOND said this complex subject needed further work. We need to be clear about how we assess probabilities and convey them to the public. It is important that the public appreciate the risk and know what to do.

Sir Geoffrey Chipperfield KCB

Open this document with Adobe Reader outside the browser and click on the URL to go to the sites below.

Useful reports and books:

The National Flood Resilience Review, Cabinet Office
www.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf

The Property Flood Resilience Action Plan, Defra
www.gov.uk/government/uploads/system/uploads/attachment_data/file/551615/flood-resilience-bonfield-action-plan-2016.pdf

The cure for catastrophe, Robert Muir-Wood, 2016,
Oneworld Publications, ISBN 978-1-78607-005-0

Statistical Analysis of Extreme Values with Applications to Insurance, Finance, Hydrology and Other Fields
Rolf-Dieter Reiss and Michael Thomas, 2007,
Birkhäuser Science, ISBN 978-3-7643-7230-9

An Introduction to Statistical Modelling of Extreme Values, Stuart Coles, 2001,
Springer, ISBN 1-85233-459-2

Useful links:

AIR Worldwide
www.air-worldwide.com

AON Benfield
www.aonbenfield.com

Association of British Insurers
www.abi.org.uk

Aviva
www.aviva.co.uk

Berkshire Hathaway
www.berkshirehathaway.com

BRE Group
www.bre.co.uk

Cabinet Office
www.gov.uk/government/organisations/cabinet-office

Guy Carpenter
www.guycarp.com

Centre for Hydrology and Ecology
www.ceh.ac.uk

Committee on Climate Change
www.theccc.org.uk

Corelogic (EQECAT)
www.corelogic.com

Cranfield University
www.cranfield.ac.uk

Department for Business, Energy & Industrial Strategy
www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy

Department for Communities and Local Government
www.gov.uk/government/organisations/department-for-communities-and-local-government

Department for Environment, Food and Rural Affairs
www.gov.uk/government/organisations/department-for-environment-food-rural-affairs

Department for Transport
www.gov.uk/government/organisations/department-for-transport

Environment Agency
www.gov.uk/government/organisations/environment-agency

Flood Re
www.floodre.co.uk

Government Office for Science
www.gov.uk/government/organisations/government-office-for-science

Highways England
www.gov.uk/government/highways-england

Imperial College London
www.imperial.ac.uk

JBA Consulting
www.jbaconsulting.com

Professor Bas Jonkman, Delft University of Technology, The Netherlands
www.citg.tudelft.nl/snjonkman

Lloyd's of London
www.lloyds.com

Met Office
www.metoffice.gov.uk

Munich Re
www.munichre.com

National Oceanography Centre
www.noc.ac.uk

Natural Environment Research Council
www.nerc.ac.uk

Network Rail
www.networkrail.co.uk

Oasis Loss Modelling Framework
www.oasislmf.org

Public Health England
www.gov.uk/government/organisations/public-health-england

RCUK
www.rcuk.ac.uk

Risk Management Solutions (RMS)
www.rms.com

RSA Group
www.rsagroup.com

Royal Academy of Engineering
www.raeng.org.uk

Science and Technology Facilities Council
www.stfc.ac.uk

Swiss Re
www.swissre.com

Professor Jonathan Tawn, Lancaster University
www.maths.lancs.ac.uk/~tawn/

The Foundation for Science and Technology
www.foundation.org.uk

University College London, Institute for Disaster Reduction
www.ucl.ac.uk/rdr

Willis Towers Watson
www.willistowerswatson.com

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