Flooding after Storm Desmond

PERC UK 2015

Flooding in Cumbria after Storm Desmond

PERC UK 2015

The storms that battered the north of England and parts of Scotland at the end of 2015 and early 2016 caused significant damage and disruption to families and businesses across tight knit rural communities and larger towns and cities. This came just two years after Storm Xaver inflicted significant damage to the east coast of England. Flooding is not a new threat to the residents of the Lake District, but the severity of the events in December 2015 certainly appears to have been regarded as surprising.

While the immediate priority is always to ensure that these communities and businesses are back up on their feet as quickly and effectively as possible, it is also important that all those involved in the response take the opportunity to review their own procedures and actions. It is often the case that when our response is put to the test in a 'real world' scenario that we discover things that could have been done better, or differently, and can make changes to ensure continuous improvement. This is true of insurers as much as it is of central and local government and the emergency services, because events like these demand a truly integrated response.

In this report, we set out to review the complete risk management cycle surrounding Storm Desmond, which caused severe flooding across Cumbria and the north of England, in December 2015. We offer some of our key findings from the review, an understanding of the severity of what turned out to be another exceptional flood event, the varying levels of flood risk awareness, preparedness and response amongst homeowners and businesses in the affected area, the variable levels of community awareness of residual flood risk and the effectiveness of emergency plans for when flood defence measures are overwhelmed. We have also looked at the role of community flood action groups in the response and recovery from severe flooding.

Our main recommendations revolve around three key themes. The first is around flood risk communication, including the need for better communication of hazard, risk and what actions to take when providing early warning services to communities. The second centres around residual risk when the first line of flood defences, typically the large, constructed schemes protecting entire cities or areas, are either breached or over-topped. There is a need to apply and operationalise integrated flood risk management more effectively, and to share the responsibilities to protect communities and businesses amongst the various actors in order to maximise protection levels, given the limited resources that are available. The third recommendation is to learn about and to utilise better alternatives to sand bags. A range of alternative products are now available and are easier to deploy, more cost-effective and more reliable than sandbags. Communities, organisations and businesses need to be aware of these and their associated benefits and limitations.

PERC UK 2015 – Flooding after Storm Desmond (continued)

Some of these findings are not completely new and are similar to those made after the floods following Storm Xaver. Our recommendations are just as applicable now as they were back then. Where does this leave us in the current resilience discussion? What have we learnt since, and what hinders us to implement the lessons better or more quickly? These are some of the pressing issues that we want to address in this PERC Report on Storm Desmond.

Communication and awareness are key to managing flood risk. In particular there is a need for a much greater appreciation and recognition that even the best defences can be over-topped. The assessment, communication and management of this residual risk is a critical factor for improved flood resilience. All those who may benefit from defences works of any form need to know that a scheme cannot offer complete protection; risk is hardly ever reduced to zero. The key questions are whether we, as a society, are aware of the protection level we are provided with, if we understand the consequences associated with the potential loss and critically, are we ready, willing and able to accept the consequences should an event occur that exceeds these protection standards?

Evidence collected after the Storm Desmond flooding highlights how difficult it is to understand residual risk and how few plans were in place to manage this. Advanced planning and well-designed community measures involving property protection, temporary barriers and emergency plans, as well as many other practicable measures, should be considered as an integral component of any future defences measures.

In encouraging natural catchment solutions to reduce flood risk, we must always recognise the continued importance of structural, engineered defences and management of urban and rural drainage. All these approaches are needed. We need more innovative, lower cost solutions where costly structural defences cannot be justified, such as property protection and improved resilience offered by community temporary flood barriers and other measures on individual properties.

Ultimately, all parties need to contribute to the principle of 'integrated flood risk management' strategies that evolve and adapt to local requirements. The real difficulty seems to be for the various agencies, organisations and individuals to 'buy into' and adopt in practice this integrated approach to managing flood risk and building resilience. One of the central purposes of this report is to advance the concept of integrated risk management as a key factor of reducing flood losses in communities such as those affected by Storm Desmond. In putting this publication together, numerous professionals and volunteers across a wide range of organisations have provided information, insights and most importantly their time. We would like to thank all those who have taken part in the PERC process. There are clear challenges ahead and concerted action is required from all parties to ensure that the UK is effectively prepared for future extreme weather events.

Conor Brennan
Head of General Insurance, UK

Rob Lamb
Director, JBA Trust

> "There are clear challenges ahead and concerted action is required from all parties to ensure that the UK is effectively prepared for future extreme weather events."

What is PERC?

As part of Zurich's flood resilience programme, the post event review capability (PERC) provides research and independent reviews of large flood events. It seeks to answer questions related to aspects of flood resilience, flood risk management and catastrophe intervention. It looks at what has worked well (identifying best practice) and opportunities for further improvements. This PERC analysis was written by Zurich in collaboration with the JBA Trust, following the recently published **PERC methodology manual** and the **Zurich flood resilience alliance framework**.

Since first developing the PERC methodology in 2013, we have been able to apply it to 9 different large events and published our PERC manual, inviting pertinent organisations to use the method freely to contribute to a growing body of learnings from these devastating floods. If these learnings find their way into decision-making and action, we hope to contribute to the reduction of human tragedy as well as property losses.

Executive summary

This report is produced as part of Zurich's global flood resilience programme and the JBA Trust's mission to improve knowledge about flood risk. Launched in 2013, Zurich's global flood resilience programme aims to increase understanding of flood resilience and advocates better protection and prevention before a flood event occurs in order to minimise its impact and resulting disruption. As part of the programme, we seek to learn from what happens during and after significant flood events – our Post Event Review Capability (PERC).

Over the years, the **PERC methodology** has evolved and here we apply the latest version of our PERC manual now publicly available[1], to the Desmond flood event in Cumbria in the United Kingdom. This report follows two years after we published the Xaver report, after an unprecedented series of flood events in the UK in the winter 2013/14 where unexpected and record-breaking flooding caused billions of pounds in losses and immense stress to all those whose homes and businesses were flooded.

While this report focuses on flooding following Storm Desmond, we appreciate that Desmond was quickly followed by two further storms, Eva and Frank, causing more damage and, in parts, overwhelming the capabilities of the population and the emergency services, who had just started the recovery phase from Desmond. This report was produced with the help of a variety of contributors and is based on desk research, phone interviews and field research in Cumbria. It draws on public information, expert insight and opinion, JBA's expertise in flood management and Zurich's experience as an insurer in the affected areas.

[1] https://www.zurich.com/en/corporate-responsibility/flood-resilience/learning-from-post-flood-events

Executive summary (continued)

Record breaking rainfall and river levels caused the overtopping of flood defences in locations surpassing anything that had been experienced before

While many flood defences were overtopped during Desmond these defences had in many previous flood events reduced or eliminated losses. The Cumbria flood event clearly illustrates that physical defences have design limits and can be overtopped (even if they do not fail in a structural or geotechnical sense), in which case losses still can and ultimately will occur. Since it is not generally acceptable to build defence walls to excessive heights, we as society, and especially those influencing flood risk and protection such as policy makers and land use planners, need to understand that there is residual risk. We emphasise the need for a public discourse to design and implement a flood risk management strategy, which includes multiple lines of defences at both the individual and municipal levels. In particular, property owners and individuals need to know the level of risk protection afforded them by flood defences walls, and what options are available for reducing their own personal risk further. Communication should be targeted at raising community awareness of their own individual flood risk and encourage individuals, businesses and organisations to take an active role in managing it. Yet, just raising community awareness is not enough. People in their communities need to actively participate and be involved in the decision making process around flood risk management and have access to cost-effective tools and advice to respond to flooding incidents.

Cascading failures and long-lasting effects on society

Primary flood losses, such as the failure of a bridge or an electric transformer station, or the loss of a school building, often leads to multiple failures and disruption down the line, which may far outweigh the primary loss. In total, more than 6,000 families were left homeless just before Christmas. It will take years to get everybody back to a 'new normal' – indeed many people's lives will never be the same as they were before.

The cost of this personal and social devastation cannot be accounted for when counting up the value of damaged or destroyed houses. For example, in Carlisle a majority of pupils could not go to school for some time after the flooding, jeopardising their educational outcomes and leaving parents at home supervising their children, potentially missing work or other important aspects of life. The loss of transport systems led to increased travel times, detours and a loss of productivity that was felt throughout the United Kingdom and potentially beyond.

A wider approach to resilience and risk reduction including corresponding incentives is needed

Besides building flood defence infrastructure, current physical resilience discussions in the United Kingdom have tended to concentrate on property-level dry or wet proofing. This narrow concept of resilience does not address the multiple pathways that a more holistic approach to resilience can provide. The desired outcome must be to ensure people are able to pursue their economic and/or personal goals and enrich their communities' lives in the face of flood risk, and not just to avoid physical losses. Mitigating psychological, cultural and ecological damage becomes a much higher priority when thinking about the long-term wellbeing of a society located in flood-prone areas.

In conclusion

Practical and applied thinking can make a meaningful contribution to flood resilience. However, if we are to apply a truly holistic approach to the resilience discussion then we must also place human and social aspects at the centre of the debate. The desired outcome cannot simply be the provision of physical protection alone but must also be to strengthen community functions and wellbeing as part of the process

Introduction

Since 2013, Zurich's Post Event Review Capability (PERC) as part of its global Flood Resilience Programme has analysed flood events in locations from Western Europe to Nepal to Morocco. We conduct our research in order to understand what has worked well and what has gone wrong during large flood events. We engage in dialogue with authorities, affected people and organisations in the disaster risk management space. We collect this information, knowledge and insight in order to provide the key findings on what happened and why, and to formulate actionable recommendations that can help build resilience.

PERC research is not intended to produce just individual stand-alone reports. By consolidating the findings across all studies and contexts so far, we show that patterns do emerge and thus pathways for how we can learn from each other. Concurrently with this PERC report for the UK floods following Desmond, a similar report is being produced for the 2015 South Carolina floods in the United States. This type of learning is very important to move global resilience forward in view of the renewed Sendai Framework for Disaster Risk Reduction. All our **PERC insights** and their consolidated recommendations are made publicly available[2] and form part of a growing repository of flood resilience insights, to which we invite others to contribute using our publicly available PERC methodology manual. Additionally, we increasingly interlink our thinking on flood resilience using the Zurich Alliance's flood resilience framework for our community programmes, and the PERC methodology for learning from past flood events.

Over the past years, the United Kingdom has seen a series of record-breaking rainfall events, leading to damaging river floods, alongside tidal surges and coastal flooding. **The latest numbers from the Environment Agency**[3] indicate over 2.4 million properties in England are at risk of flooding from rivers and the sea, and a total of 2.8 million from surface water. This means that roughly one in six properties in the United Kingdom are exposed to flooding, and the number is set to rise for a variety of reasons, including climate change and demographic changes. Recent publications by the Environment Agency indicate that by the 2080s, peak river flows may increase relative to a 1961-90 baseline by between 30% (a central estimate) and 70% (under more pessimistic, but still-plausible assumptions).

We highlighted such findings only two years ago with the publication of our PERC Xaver storm surge report and provided key insights and recommendations for that event. Not quite two years later, we seem to be in a very similar situation, and in fact, some of the findings are remarkably similar to the findings in Xaver and other PERC reports. This points to more systematic problems and how flood risk manifests itself in very similar forms across various contexts around the globe.

[2] www.zurich.com/en/corporate-responsibility/flood-resilience/learning-from-post-flood-events

[3] http://www.nationalfloodforum.org.uk/wp-content/uploads/Flood-Re-Transition-Plan-Feb-2016-FINAL..pdf

Introduction (continued)

This report is focussed on the events during early December in the Cumbria area of the United Kingdom. We investigate what happened during Desmond and why, with information, key insights and recommendations broken down into the following sections:

Section 1

A review of the weather events, starting with a very wet November and then a series of intense rainfall events. We focus on those that originated in Storm Desmond and focus geographically on Cumbria.

Section 2

A description of the disaster risk management landscape of the locale, helping set the scene for why the flooding impact, response and recovery unfolded as they did.

Section 3

A review of what happened, taking into account information and insights from prior flood events in the area in 2005 and 2009. The analysis follows the disaster management cycle – prevention and risk reduction using structural measures and reducing loss potentials, early warning and preparedness, coping and response, finally recovery and outlook for the future, taking into account corrective risk reduction as well as avoiding the build-up of future risk.

Section 4

A summary of the key insights in this study based on our review of the event in the previous section

Section 5

Identifies opportunities and offers recommendations for action. We aim to provide these recommendations in a form that is as actionable, concise and as practical as possible in order for authorities and organisations to make better-informed decisions about future flood risk management and resilience-building.

Section 6

Provides a short discussion of the relevance of these findings at the regional and global levels in, putting the findings from this review in global context with other post event reviews conducted by the Zurich Flood Resilience Alliance and others in the field of natural hazards forensic research.

Section 1 – A hydro-meteorological analysis of the floods

In December 2015 Storm 'Desmond' brought high winds and heavy rainfall to Southern Scotland, the north of England, Wales and Ireland. As a result severe flooding was reported in the north of England, particularly in Cumbria.

High rainfall from Friday 4th to Sunday 6th December and sustained high river flows caused widespread flooding in Cumbria and North Lancashire. It is thought the severity of flooding was exacerbated by the already saturated ground conditions from the previous storms of Abigail, Barney and Clodagh. The UK Met Office gave the name Desmond to a large low pressure system identified on 3rd December south of Newfoundland, Canada. Desmond moved east, combined with another storm to the north, and brought heavy rainfall and strong winds to Northern Ireland, northern England, Wales, and southern Scotland. Desmond strengthened as it travelled across the Atlantic, gaining considerable moisture from the Caribbean as it passed. This situation can be described as an 'atmospheric river', as shown in precipitable water imagery (Figure 1).

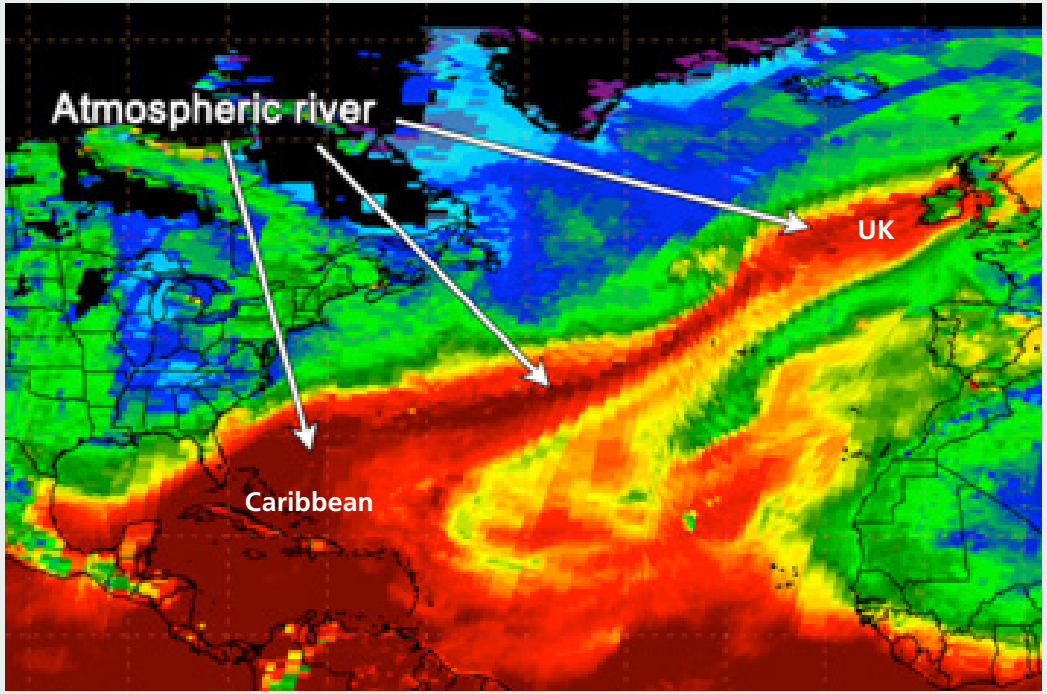


Figure 1. Precipitable water imagery on satellite shows an atmospheric river stretching from the Caribbean to the U.K. (National Weather Service Twitter publication).

Section 1 – A hydro-meteorological analysis of the floods (continued)

Storm Desmond eventually stalled over the northeast of England and Scotland rather than continuing on its easterly path. It led to extreme rainfall over parts of the region, particularly over the upland areas of the Lake District and northern Lancashire (Figure 2).

The rainfall associated with Desmond was record-breaking in several respects. Compared against all available data that the Met Office holds, which go back to the 19th Century in some places, the new records set were:

- Highest 24-hour rainfall record for UK on the 5th December (341.4mm, Honister Pass, Cumbria)
- Highest 48-hour rainfall record for UK (405.0mm, Thirlmere, Cumbria in just 38 hours)
- Wettest calendar month on record for UK (191% of December average) in a series from 1910.

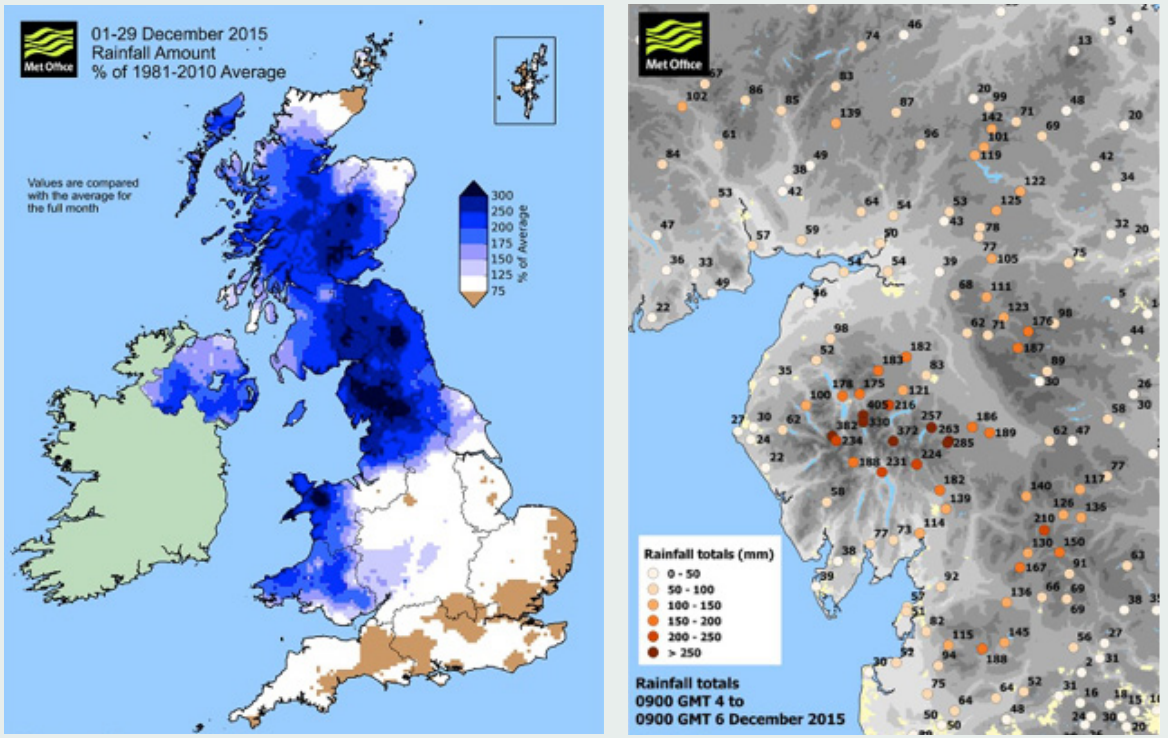


Figure 2. Rainfall during December 2015 as a percentage of long term average for December (left) and rainfall totals in mm during Storm Desmond (right), (Met Office).

Section 1 – A hydro-meteorological analysis of the floods (continued)

Figure 3 shows the hourly rainfall with accumulated totals recorded by the four highest-recording rain gauges in the Lake District. The steady, almost straight lines on the graph highlight the unusually sustained intensity over a relatively long period of days.

Cumbria and North Lancashire experienced the most severe flooding from Storm Desmond. The worst affected areas were identified as Carlisle, Kendal, Cockermouth, Keswick, Appleby-in-Westmoreland, Morecambe and Lancaster. Exceptionally high peak flows were observed in several rivers. Provisional measurements of peak flows resulting from Storm Desmond on the Rivers Eden, Tyne, and Lune were all approximately 1,700 m³/s. These are the highest flows ever recorded in England and Wales (based on gauged records held on the UK National River Flow Archive, dating back to the late 19th century in some cases). The data is described as provisional here because there are inevitably some uncertainties in measurements of extreme river flows, and it may be some time before definitive flow estimates are available.

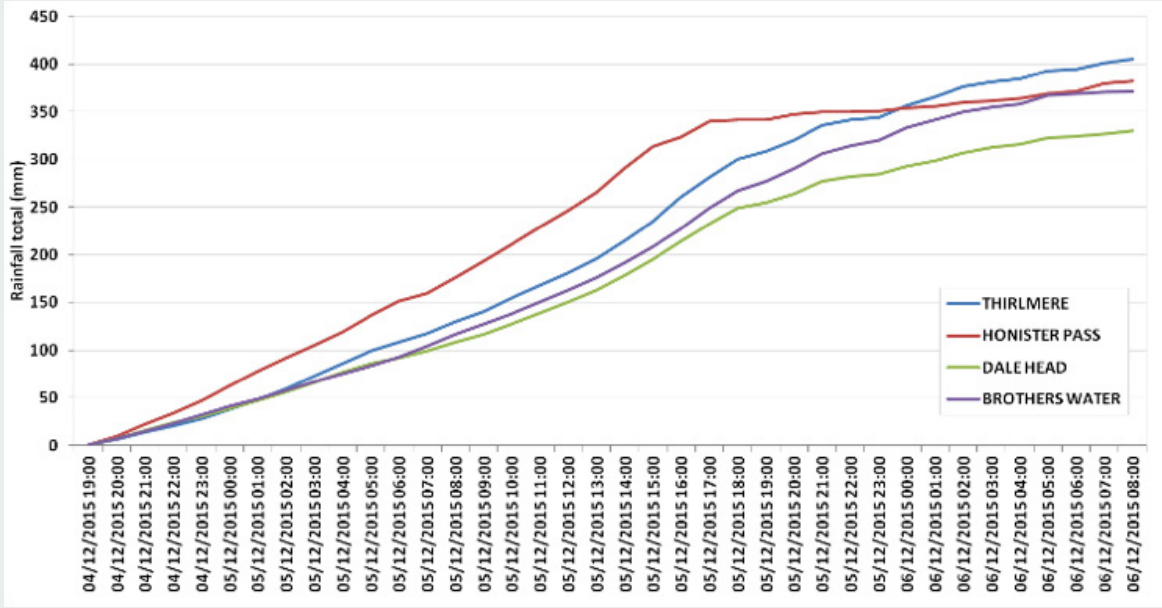


Figure 3. Rainfall accumulations from 4 to 6 December 2015 derived from Met Office published data (http://www.metoffice.gov.uk/climate/uk/interesting/december2015).

Section 1 – A hydro-meteorological analysis of the floods (continued)

Based on information currently available (Table 1), it appears that on many Cumbrian rivers, Storm Desmond led to record-breaking flows, surpassing previous floods in 2005 and 2009 which were themselves extreme compared with previous decades. Even when longer-term historic records are considered, based on documentary evidence or flood marks dating back to the 19th century, the peak flows were outstanding in many places.

Table 1: Reported river flow measurements in context of previous records

River gauge	Peak flow (m^3/s) for Desmond	Previous record peak flow (m^3/s)	Date of previous peak	Period of record available
River Eden at Carlisle	1680	1516	8 Jan 2005	From 1967
River Eamont at Udford near Penrith	580	417	19 Nov 2009	From 1960
River Kent at Victoria Bridge, Kendal	403	286	8 Jan 2005	From 1974 although historic data back to 1831 (possibly incomplete) include a flood of around 368m^3/s in 1898.
River Leven at Newby Bridge, outlet of Windermere	224	239	20 Nov 2009	From 1938
River Derwent at Ouse Bridge, outlet of Derwentwater	Between 390 and 450	378	20 Nov 2009	From 1967
River Lune at Caton near Lancaster	Around 1700	1395	31 Jan 1995	From 1968 although historic data from 1892-1965 do not contain any floods as high as the 1995 event.

Looking beyond Cumbria, throughout the north and west of Britain exceptionally large volumes of water flowed in rivers in December 2015 relative to long term averages for the month of December (Figure 4).

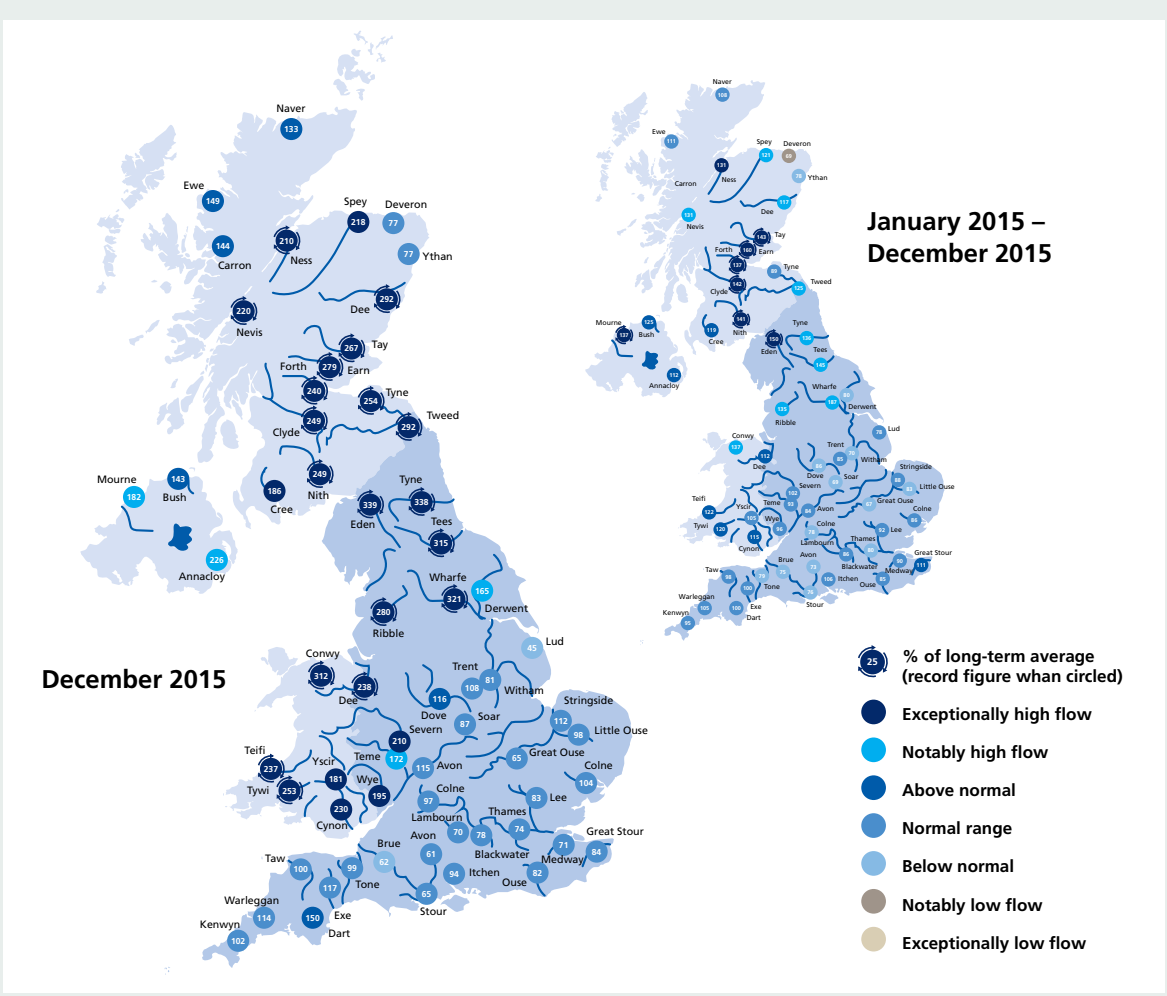


Figure 4. River flows in Southern Scotland, England, Wales and Northern Ireland in December 2015 as a percentage of long term averages. (http://nrfa.ceh.ac.uk/sites/default/files/Latest_Hydrological_Summary.pdf).

Section 1 – A hydro-meteorological analysis of the floods (continued)

The footprint of the river flooding is shown in Figure 5, which is compiled using a combination of initial observations from river flow gauges and hydraulic floodplain modelling (note that some areas of lakes are also shown).

It is clear that both the meteorological and hydrological events were extreme and record-breaking in many respects. Analysis based on recently-released rainfall frequency statistics (FEH13), suggests that the probability of the rainfall observed at Honister Pass being experienced in any given year would be around 1 in 1,300. By global standards the UK has a long-established, dense and high-quality network of rainfall and river flow measurement gauges, which, combined with other sources of information such as rainfall radar and post-event research projects contribute to a large body of knowledge about major flood events. However, these data sources are complex and require careful checking and interpretation, which means that a full and comprehensive hydrological account of the events is still to emerge.

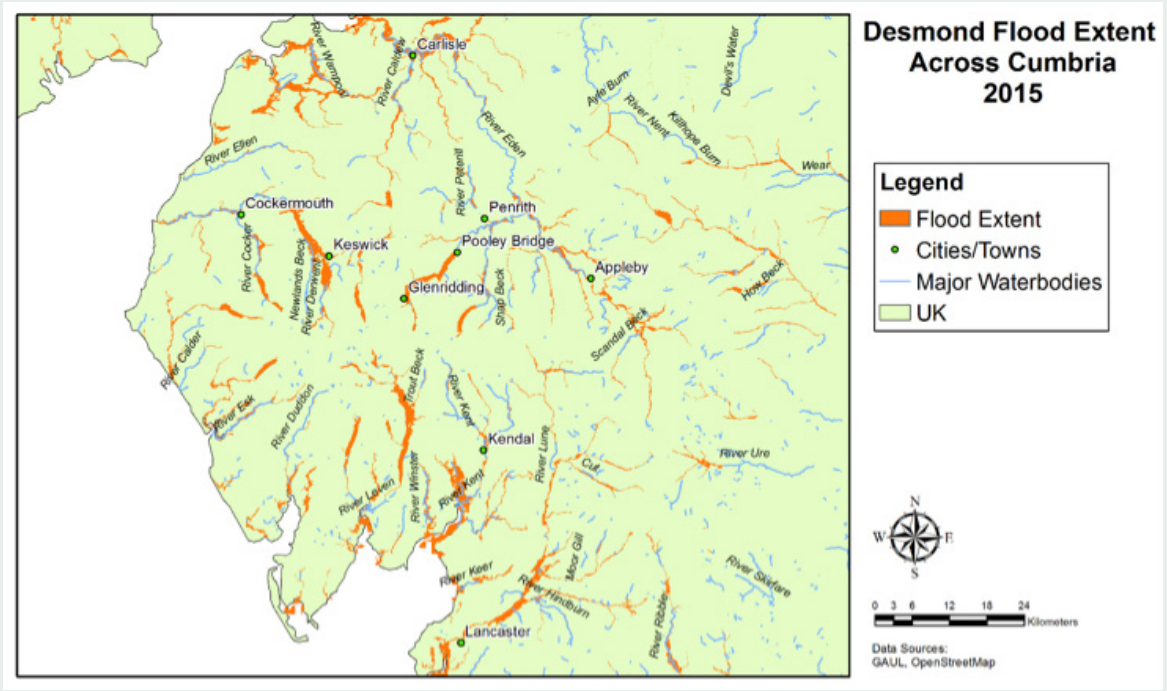


Figure 5. Flood footprint from Storm Desmond (co-production by IIASA and JBA). The Desmond Flood Event Footprint is a JBA derived dataset. It has been generated on the basis of a technique that uses the rarity of the local flooding experienced as measured at key gauges to stitch together the flood map with the same rarity.

Section 2 – The Flood Risk Management Landscape in the UK and Cumbria

At the national level, the **Department for Environment, Food & Rural Affairs (Defra)** is responsible for providing protection against a range of natural hazards, including the provision of flood risk management and flood warnings. **The Environment Agency (EA)**, which receives its funding from Defra, is specifically responsible for flood defences on main rivers and the coast and has a strategic overview role for all types of flooding. One of the EA's main roles is to build, improve and maintain flood defences such as maintained river channels, raised embankments, floodwalls and culverts. The EA is responsible for over 25,000 miles of flood defences and aims to ensure that 95% of them perform as designed during a flood event.

To support its work, the EA produces **Catchment Flood Management Plans (CFMP)** for 68 main catchments in England. These are high-level planning tools which specifically set out objectives for flood risk management across each catchment and identify flood risk management policies that are economically practical. These plans are expected to have a potential life of 50 to 100 years.

The EA also works in partnership with the **Met Office** to provide early warnings of possible flooding. The **Flood Forecasting Centre (FFC)** combines meteorology and hydrology expertise to forecast river, tidal and coastal flooding, as well as extreme rainfall which might lead to surface water flooding. This then feeds into the agency's Floodline, its early warning flooding service.

At the local level, **Lead Local Flood Authorities (LLFA)** have an increasing responsibility for the management of local flood risk, which includes surface runoff, groundwater and flooding from ordinary watercourses (smaller rivers and streams). In the North West River Basin District the Environment Agency works with 23 LLFAs, other local councils, Highways England, and the major private regional water and wastewater company, United Utilities, to manage flood risk. **Cumbria County Council (CCC)** has an established role in local flooding as LLFA. However, the **Flood and Water Management Act 2010 (FWMA)** does not provide Cumbria County Council with the mandate or funding to tackle all identified causes of flooding.

Below the local area at an area level in England, the primary responsibility for planning for and responding to any major emergency sits with local organisations, acting individually and collectively through **Local Resilience Forums (LRFs)** and **Strategic Coordination Groups (SCGs)**. The **Cumbria Local Resilience Forum (CLRF)** consists of all organisations and agencies involved with emergency response in Cumbria communities. They have decisive power but work by the principle of subsidiarity, emphasising that local decision making will be supported, as necessary from a higher level.

Section 2 – The Flood Risk Management Landscape in the UK and Cumbria (continued)

From a governance perspective, emergency management relating to flood incidents is nationally governed by the **National Flood Emergency Framework for England** and its detailed guidance to developing a multi-agency flood plan. This Framework sets out the government's strategic approach to floods and is intended for use by 'all those involved in planning for and responding to flooding'. This document is specifically limited to emergency intervention and not the recovery phase of a flood incident. It is based on the **Civil Contingencies Act 2004 (CCA)** and defines flooding as an emergency as 'a situation or series of events that threatens or causes serious damage to human welfare, the environment or security in the United Kingdom.

Beyond Defra and the EA, charities have also begun to play an increasing role. The **National Flood Forum (NFF)** is a national charity dedicated to supporting and representing communities and individuals at risk of flooding. The NFF does this by helping people to prepare for flooding in order to prevent or mitigate its impacts, to recover their lives once they have been flooded and campaigning on behalf of at-risk communities and working with government and agencies to ensure that they develop a community perspective.

In addition to the public investment in flood risk reduction made through the work of the Environment Agency and Local Authorities, risk transfer occurs through flood insurance. Flood risks are insured through the private insurance market in the UK, with the Association of British Insurers (ABI) acting as a trade body representing the majority of the industry. Its members are vital in providing cover and handling claims for damages caused by a flood.

Financial mechanisms for coping with floods and recovery after flooding are available mostly on a grant-basis, agreed upon and financed at national level but managed through the responsible councils. In the case of the 2015 Cumbria floods, this comprised the £500 emergency grants and the £5,000 flood resilience grants, as well as agricultural recovery grants.

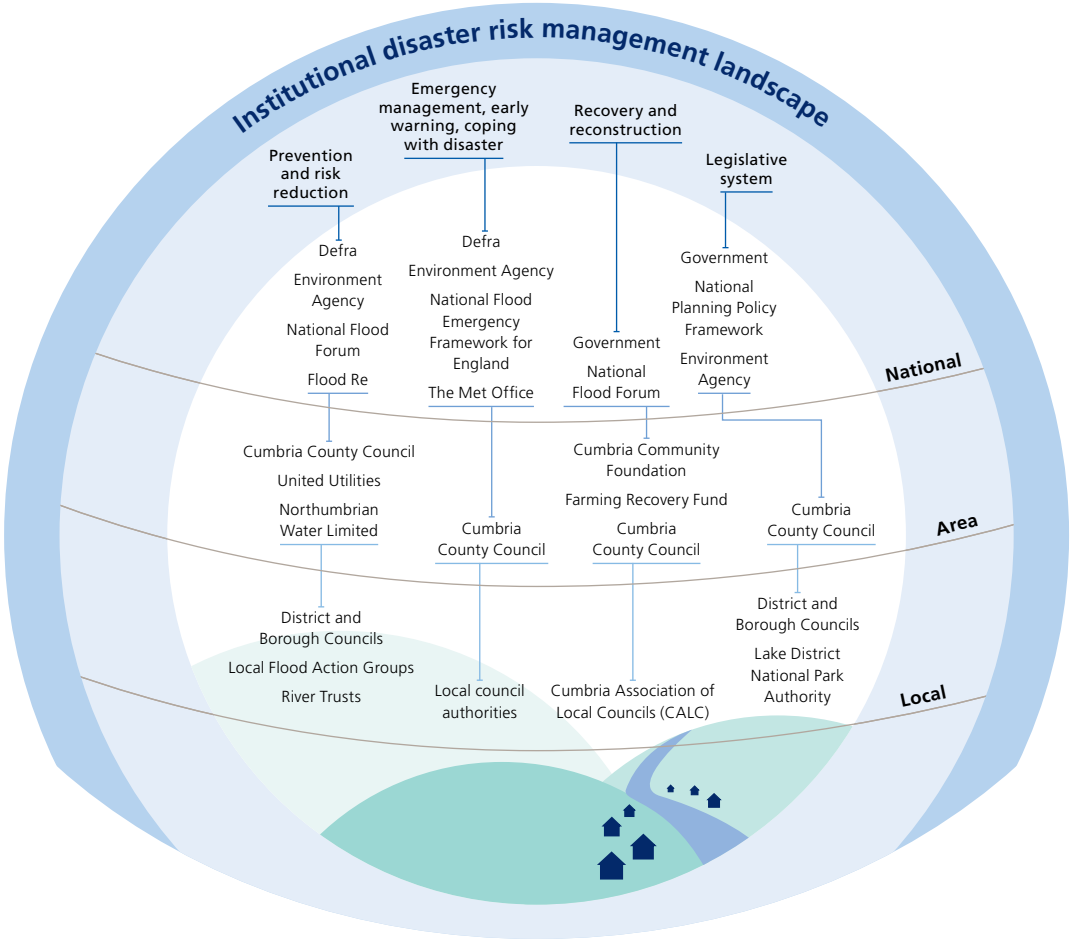


Table 3: Institutional disaster risk management landscape

Disaster Risk Management Landscape	Prevention and risk reduction	Emergency management, early warning, coping with disaster	Recovery and reconstruction	Legislative system
National level	**Defra/Environment Agency** has the main responsibility for flood management and defence in England. It assists planning and development control through the provision of information and advice regarding flood risk and flooding related issues. Flood hazard and flood risk mapping is also performed by the EA to transparently display hazard and risk levels at any given location in the UK and to promote risk reduction measures compatible with the flood hazard level. The EA produces **Catchment Flood Management Plans (CFMP)**. Financial risk transfer: Private property and flood insurance market, coordinated through the Association of British Insurers (ABI), in combination with **Flood Re**, which became operational in April 2016 (www.floodre.co.uk).	**Defra** ensures that structures and resources are in place so that the Flood Management team and other parts of Defra can play their part, mostly a national coordination and information triage part, during the emergency response to a flood. **Environment Agency:** monitors river levels within main rivers and makes assessment of the anticipated maximum water level likely to be reached. Where predicted water levels are expected to result in inundation of populated areas, they issue flood warnings through **Floodline Warnings Direct**. **The Met Office** maintains and progresses rainfall monitoring and forecasting. Through the Flood Forecasting Centre (FFC) it works in partnership with the EA to forecast flooding, including extreme rainfall which may lead to surface water flooding. Immediate coping assistance: The government is providing local authorities with **Community Grants as part of the Communities and Business Recovery Scheme** with over £500 for each household affected to help with temporary accommodation and immediate emergency measures needed.	Recovery and reconstruction of affected properties and interrupted businesses paid for as part of the insurance coverage provided by national (or international) insurers writing policies in the United Kingdom. **Government responsibility:** Grant of £5,000 per affected household to protect against future flooding under the **Household Flood Resilience Grant Scheme** intended to fund measures which improve the property's future protection or resistance to flooding. Applications are managed through the local council. Under the **Communities and Business Recovery Scheme**, the UK government also provided local authorities with funding of £2,500 for every business affected. **National Flood Forum:** Independent support and advice, lobby function, works as a non-profit.	**Government responsibility:** Flood and Water Management Act 2010 makes county and unitary authorities Lead Local Flood Authorities (LLFAs) with a responsibility to manage local flood risk. The **National Planning Policy Framework (NPPF)** sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow – where these tests are not met, national policy is clear that the development should not be allowed. Paragraph 100 of the NPPF specifically states that local planning authorities should take advice from the **EA** and other relevant flood risk management bodies.

Table 3: Institutional disaster risk management landscape

Disaster Risk Management Landscape	Prevention and risk reduction	Emergency management, early warning, coping with disaster	Recovery and reconstruction	Legislative system
Area level	**Cumbria County Council**, **United Utilities** and **Northumbrian Water Limited** work together. CCC has powers and duties for strategic overview of local flooding and some flood-risk management functions. **UU & NWL – Sewerage Undertakers** are responsible for public sewer system and as such are responsible for managing the risks of flooding from surface water, foul or combined sewer systems.	**Cumbria County Council:** As water levels rise and begin to pose a risk to life and/or livelihood, it is the CCC's responsibility to coordinate the evacuation of residents. This evacuation will be supported and facilitated by the emergency services. It is also the body responsible for the Emergency Planning during major events. It has a long established Multi-Agency Flooding Response Plan covering co-ordination of an emergency i.e. receptor centres, welfare, etc. (plans exercised regularly and have stood the test of real events). Category 1 and 2 Responders are responsible for preparation of contingency plans that detail how all emergency responders will respond jointly under the CLRF to major flooding. As part of this role, CCC coordinates the preparation of multi-agency flood plans for each district and borough in the county and provides details of how to manage flooding incidents.	**Cumbria County Council** manages the applications and payouts of the government emergency relief and the household flood resilience grant schemes. **CALC's mission** is the recovery after a major incident. In the recovery phase, CALC works together with private and public bodies and voluntary organisations to coordinate the recovery effort. **Cumbria Community Foundation** put in place a Cumbria Flood Recovery Fund 2015 for individuals – Hardship grants were typically £500 to £2,000, in exceptional circumstances, up to £5,000 was possible. A review showed the need for hardship and community recovery funds around £9.4m, against the funds raised of £5.7m. **Farming Recovery Fund:** Farmers affected by the recent flooding could get grants of up to £20,000 to help restore damaged agricultural land.	**Cumbria County Council** is the Lead Local Flood Authority (LLFA). The CCC is the statutory consultee on major planning applications received by the Districts and on District Local Plans. It is also the planning authority for minerals and waste and for schools, roads, libraries and other developments promoted by the Council. The CCC has a duty to ensure that flood risk is taken into account in planning of new developments. A **Local Flood Risk Management Strategy (LFRMS)** is a requirement for all Lead Local Flood Authorities (LLFAs) to set out how local flood risks will be managed in the county, who will deliver them and how they will be funded. Local authorities have a duty to carry out, with the EA, a Strategic Flood Risk Assessment (SFRA). This forms part of the evidence base that contributes to Local Development Frameworks.

Table 3: Institutional disaster risk management landscape

Disaster Risk Management Landscape	Prevention and risk reduction	Emergency management, early warning, coping with disaster	Recovery and reconstruction	Legislative system
Local level	**District and Borough Councils** have Local Planning Authority, they are responsible for carrying out the **Strategic Flood Risk Assessment (SFRA)**, which considers the risk of flooding throughout the district and should inform the allocation of land for future development, control policies and sustainability appraisals. Local Planning Authorities have a responsibility to consult with the EA when making planning decisions. **Local Flood Action Groups:** Self-organised groups who lobby for risk reduction and resilience increase, but who also take action to advise neighbours on risk and protection and who work with the local government to secure funding for prevention schemes etc. There are **six river trusts** in Cumbria dedicated to conservation, protection, enhancement of aquatic environments (rivers, lakes, tarns, streams etc.) in their respective catchments.	**Local council authorities** manage the application and pay-out process for the £500 emergency grant provided by the UK government.	**Cumbria Association of Local Councils (CALC)** works with private organisations and the voluntary sector to coordinate the recovery effort. **Local councils** manage the government's Household Flood Resilience Grant Scheme of £5,000 per household. Eligible measures may include things like moving electrics, flood doors, waterproofing windows etc.	**District and Borough Councils** have local planning authority (LPA). They have powers to adopt and maintain ordinary watercourses within their district. Where they exist within a LLFA area, district councils retain responsibilities for delivery of flood risk management on ordinary watercourses through permissive powers. Developers must also produce a Flood Risk Assessment (FRA) to show their development proposals comply with planning policy on flooding. **Lake District National Park Authority (LDNPA)** has completed their own strategic flood risk assessment to understand flood risk within the park boundaries and to fulfill their mission of conserving the special character of the Lake District while promoting growth, development and affordable housing within its boundaries.

Section 3 – What happened

A significant impact on people's lives

Storm Desmond claimed at least three lives on the British Isles, with BBC sources in Cumbria reporting one person was swept into a river. Throughout the entire event, Defra estimated that 19,000 homes were flooded across northern England, with thousands forced to evacuate. More than 1,000 people had to be evacuated from houses in parts of Cumbria and the Scottish Borders alone.

Cumbria and Lancashire experienced the most severe flooding from Storm Desmond. The worst affected areas were Carlisle, Kendal, Cockermouth, Keswick, Appleby-in-Westmoreland, Morecambe and Lancaster. In this area, close to 8,900 properties flooded[4]. Kendal had an estimated 1,400 people left temporarily homeless. 2,000 businesses were flooded directly and a further 2,000 had indirect (business interruption) losses.

The village of Glenridding was hit hard and repeatedly. Large volumes of boulders and debris were carried and deposited in and around the normally small river flowing through the village, blocking bridges and culverts. Ultimately the water had nowhere to go but through the streets and into houses. Glenridding was completely cut off from surrounding roads and could be only reached by boat.

A local energy firm that had already spent £7.9m on flood defences, to protect its substation infrastructure against what it regarded as 'once-in-100-years floods' following the 2009 flood disaster, found that even these defences were no match for the rain in early December.

Power cuts also affected tens of thousands of households with it suggested that as many as 100,000 households were impacted. In Lancaster, for example, Morecambe, Carnforth and the surrounding area in north Lancashire, 61,000 homes lost power when a substation was flooded on 5th December. Moreover, 44 schools were forced to close throughout the region, either because they were flooded, lost power or staff and pupils could not get through. Some of these remained closed until the New Year[5]. The two main hospitals in the region, at Lancaster and Carlisle, were also forced to run on emergency generators and cancelled all routine appointments and operations[6].

This took place against the backdrop of the festive period which ultimately took an emotional toll on both individuals and businesses.

19,000
homes flooded across Northern England

100,000
estimated households impacted by power cuts

131
bridges in Cumbria needed urgent inspections and repairs

3,000
families needed emergency accommodation

[4] Defra
[5] Cumbria News newspaper
[6] The Telegraph

Social impacts of Desmond – Case study 1

An account from the National Flood Forum

Sylvia Pilling has been flooded three times in the last 10 years. She lives in Keswick with her husband. This is Sylvia's experience of Storm Desmond, recounting how she lived through the event and what her expectations are to address some of the problems.

Sylvia is 77 and her husband is nearly 80. Following the events of Storm Desmond, Sylvia decided to take action to mitigate the threat of another flood. She is now seeking to convert her home to accommodate all their living needs on the first floor in a self-contained flat and renovate the ground floor so that if, or indeed when, another flood happens she will be able to clean up, dry out and get back to normal as quickly as possible after the water has receded. For this major renovation work to happen, Sylvia must find the finances, and, with limits to how much her insurance company can pay out, Sylvia is asking the question, "how can I access further help and funds?" Sylvia does not want to move again. She says they will never be able to sell the house, which is why she would like to make life as simple and comfortable as possible under the circumstances.

"When we first flooded in the 1980s it felt like a freak occurrence but we've done some research and we now know our house also flooded in 1934 and 1956. By no means though have we flooded as frequently as we have in the past 10 years. Leading up to Storm Desmond it had been raining heavily all week. I'd been for a walk and could see the rain coming off the fells and into Thirlmere. The rain was so heavy I thought 'this is flooding rain' so on the Friday night I put the flood gates on, took the car to high ground and moved as much as I could upstairs. It was too wet and windy to move things from the garage and shed. My husband, who has severe Parkinson's could do nothing to help. On the Saturday everyone kept saying 'you'll be ok' but at about 11am people came and said it's going to overtop. Then the mountain rescue came. We had to remove the flood gates to get my husband out. We were evacuated to the school but my husband wasn't coping and took the last bed in hospital. Whilst we were there it dawned on me that I may not be able to get out of the hospital because of the flood water so they were kind enough to let me stay with him for three nights. The hardest thing is that my husband, who's nearly 80, has had to go into a care home as we don't currently have the facilities for him within our property. I'm living temporarily upstairs.

After our previous experiences we've implemented various measures such as moving the electrics higher up, relocating the boiler and building a simple kitchen upstairs, having concrete floors and tiles. So because of these measures although it was bad enough this time and the water came up to more than 2ft, it wasn't as devastating indoors as before. We lost our white goods and heavy furniture, the stuff that can't be easily lifted to a higher level, but we were able to save a lot of our personal belongings. That said, it doesn't lessen the impact of seeing all the damage and debris that a flood causes and leaves in its wake. We are the first house that the river can flow into. There was three feet of mud all over the garden and great drifts of gravel. Huge tree trunks had come down the river. The door had been ripped off the garage. The shed with three bikes and heavy garden tools had been moved several feet down the road. I've spent so much time in the garden but now it's a complete mess and my insurer won't cover it."

> "It shouldn't be at the householder's expense. It's not our fault we get flooded. We need to be able to make our home a place that is practical and useable for us to live in."

"If there's one positive thing to say about this flood, it's that there was a real sense of community spirit. School children came to help move the debris. Locals from all walks of life helped with nasty, messy and backbreaking jobs. Muslim faith groups from all over came in vans with shovels and tools to shift all the mud – Sheffield, Dewsbury, Liverpool and Surrey. They provided a meal in the local primary school. Such human kindness. But what now? The overwhelming feeling is one of resignation. I know I've got to get on but at night I wake up worrying. What am I going to do? How will I afford it? I don't want like-for-like from my insurers anymore. I want to make myself fully resilient, I want to make it better. I want to be able to live in a home where I know we're as protected as we can be. I feel worried. There's so much to do. I don't know where to start."

Sylvia had a clear view about the need for external support for households at risk of flooding, saying: "My message to government is to help people be able to reach the best possible solution for them", which echoes the aspirations of the Environment Agency to "empower communities" in its National Flood and Coastal Erosion Risk Management Strategy.

Sylvia went on to call for collective responsibility dealing with flood risk, adding: "It shouldn't be at the householder's expense. It's not our fault we get flooded. We need to be able to make our home a place that is practical and useable for us to live in. We need to be able to adapt how we live in our home so that we don't have to spend money three times in a decade returning it to the same state only for the next flood to destroy it again. We need to make it secure. It is my safe haven."

Lifelines disrupted, bridges damaged or destroyed, villages isolated

Daily life was hampered throughout the region as a result of Storm Desmond with train and bus services suspended, increased road traffic and long-term road closures. At least 22 bridges, some of them historic and connecting towns across rivers for centuries, were damaged or destroyed. The Cumbria Council website reported up to 131 bridges affected and needing urgent inspections and repairs[7].

When the historic Pooley Bridge, giving the town its name, was destroyed, it left the town divided and it took until April 2016 for a temporary solution to be put in place. The village of Braithwaite also became completely cut off when its main bridge, the Coledale High Bridge, collapsed as the river broke its banks.

[7] http://www.cumbria.gov.uk/news/2015/december/09_12_2015-114140.asp

Road closures are forcing residents of the flood communities to take detours, considerably increasing their journey times. A four mile stretch of road in the Thirlmere area was closed because the flood washed part of the road away at one end and there has been a landslip at the other. This road is the main link between Windermere, Ambleside and Grasmere in the south and Keswick in the North. For people living on the wrong side of the break, this can mean a 1.5 hour round trip, rather than a 20 minute trip. This includes a number of children who live in Grasmere but go to school in Keswick; some reportedly now have to stay with friends in Keswick during the week. These road closures have also led to access difficulties across the Lake District hampering the vital tourism industry.

However, Storm Desmond also showed some successes in risk reduction and improved emergency action following early warning. In 2005, a large bus company lost its entire fleet of 85 vehicles in their Carlisle bus depot when it flooded. Since then, advance contingency plans were made, and all vehicles could be moved out of the depot and saved in the event of a flood. In addition, drivers and their buses could even help out during the emergency intervention to evacuate people affected by flooding.

Agriculture also took a particularly bad hit during Storm Desmond. In addition to flooded fields and stock, many thousands of sheep and cattle were swept away along with numerous fields out of action, sometimes covered knee deep in rubble, gravel and deposited silt. It is estimated that losses to the farming sector are in the tens of millions of pounds altogether from the sequence of floods in December 2015. The loss of business and accessibility via road networks also led to problems with milk collections and concern about animal feed supplies. Government was trying to help the farmers through the availability of Farming Recovery Fund grants of up to £20,000 via the Rural Payments Agency (RPA) to help restore soils, rebuild tracks and repair flood channels.

Recovery and returning to 'normal'

Immediately, five rescue centres were available to those in need. Those who lost their homes were accommodated in hotels and guesthouses, a total of over 3,000 families according to latest numbers[8], while repairs are made to their homes. Depending on the extent of damage and the ease of repairs, this can take as long as half a year, which affects families, their surroundings and also their jobs. In that respect, both the affected population and the insurance industry have learnt their lessons from past events in managing expectations and making clear how long it can take to get back into the home and how much effort is needed to handle a flood claim and completely close it.

Based on lessons learnt from the past in terms of capacity and manpower needed, the insurance industry was also able to help speed up the recovery process and respond to the big demand in the most affected areas. The ABI reported that generally, the population and the government were better satisfied with the job the insurance industry did when compared to earlier floods, where both expectations and service deliveries had been different. We assume that this has mostly to do with a better understanding of the processes and complexities involved in stripping out damaged houses and the importance of a sufficient drying period to avoid future damage due to moisture. The industry is employing remediation specialists and using reinstatement plans to include resilient materials/structures where possible. However, this is not always within policy cover, the available timeframe to make urgently needed decisions, the power of those who need to make these urgent decisions or the immediate financial viability and willingness to pay of the insured who suffered the loss.

[8] ABI, 2016

Section 3 – What happened (continued)

Flood defences under scrutiny once again

Following the record-breaking river levels and the overtopping of flood defences, some of which had only been recently completed, flood defences and their financing have come under increased scrutiny. The EA stated that flood defences had protected 8,600 homes across the north of England and provided vital time for homes and businesses to be evacuated as well as reducing the impact. However, the EA also acknowledged that protection structures did not stand up to this event, stating that "the devastation has resulted in criticism of the government after multimillion-pound defences built following floods in Cumbria in 2005 failed to keep the deluge out from people's homes."

This is particularly evident in Carlisle, where £38 million had been spent on the flood defences along the river Eden following the devastating 2005 flood. The defences had proved effective during past smaller floods, yet were overtopped during Storm Desmond. The EA nonetheless confirmed that consequences of higher-frequency river flow events had been successfully prevented and estimated that the £38 million investment had paid for itself already more than twice[9].

Following the events of Storm Desmond, there has been a significant discussion around the perceived failure and/or overtopping of flood defences. However, at this point in time, and in discussion with the Environment Agency, there is no known case of defences failing (i.e. being destroyed or failing structurally, and therefore providing no protection), but rather overtopping occurred because the event was larger than the implemented protection level.

In order to ensure flood protection levels can at least be maintained for a potential future flood after they had been tested to sometimes beyond their limits, the EA has allocated priority resources and staff for inspection and repairs. An extensive repair programme with funding of around £10 million is ongoing in Cumbria, and more than 3,000 flood defences had been inspected and around 100 repair projects initiated at the time of writing of this report.

Economic and insured loss estimates higher than before

The 2009 floods were estimated to have cost £376 million according to Cumbria County Council with towns such as Cockermouth taking years to rebuild. Recovery from 2015's floods is predicted to take longer and cost more. Currently, the overall insured flood loss is estimated at £520 – £662 million[10]. In 2009 when Cumbria was hit by flooding, the insurance industry had paid an estimated £175m – £206m[11] of claims, with the total cost reaching £275m. Insurance had to handle roughly 36,000 flood and storm claims back then. Current claims volume stands already at more than 15,000 for property damage and 5,600 for motor for Desmond flood claims alone. Total property claims numbers are expected in the range of 24,000.

The ABI now calculate overall economic damage for the nation from the December floods at £1.3 billion, a number which seems fairly stable based on latest information available. However, it must be noted these figures combine the separate storms Desmond, Eva and Frank throughout December 2015.

£520–£662
million 2015 estimated insured flood loss

24,000 estimated total property claims following 2015 floods

£1.3 billion ABI estimated total economic damage

[9] Cumbria News
[10] ABI; PERILS AG, 2016
[11] ABI, 2010

Compensation schemes available

Flood-hit families and businesses will be in line to benefit from a £50m relief fund, announced by the previous Chancellor. With the funding, local authorities are able to provide £500 to each flooded household to assist with temporary accommodation costs. Each affected home will also be eligible for a flood resilience grant of up to £5,000 to spend on safeguarding the property against future floods, such as installing barriers and moving electricity sockets.

Further financial compensation was confirmed by Farming Minister George Eustice who announced that support payments worth up to £20,000 would be made available to farmers across Cumbria and North Lancashire who have been affected by flooding to help restore damaged agricultural land. The payments are part of a £40 million Community Recovery Scheme announced by the Chancellor to help hard-working people in flood-hit areas following the record rainfall in parts of North West England, taking the total of government support pledged to over £60 million.

Future risk reduction and flood protection

According to the Eden Catchment Flood Management Plan[12], there are 4,500 residential and 1,000 commercial properties at a 1% or greater annual risk of flooding from the Eden river. A significant flood event in recent years occurred in January 2005, when flooding affected approximately 2,700 residential properties across the catchment, Carlisle being badly affected. In the future it is estimated climate change could increase the number of properties at risk to 4,800 residential and 1,060 commercial properties along the Eden.

Almost 90% of the properties at risk in the Eden catchment are in Carlisle. Carlisle has benefited together with other towns, from engineering schemes put in place over the last 50 years or more. The scheme in Carlisle is designed to provide a 0.5% standard of protection and at Appleby provide a Standard of Protection (SOP) of 1%[13], promoting resilience and resistance measures for those properties already in the floodplain. Many properties on the Sands at Appleby have benefited from flood resistance and resilience measures in a trial project funded by Defra.

The government has announced investments of £2.3 billion in flood defences over the next 6 years which is a real terms increase on the £1.7 billion in the last Parliament.

This in turn is a real terms increase on the £1.5 billion spent between 2005 and 2010.

> “The government has announced investments of £2.3 billion in flood defences over the next 6 years.”

[12] CFMP, 2009
[13] CFMP, 2009

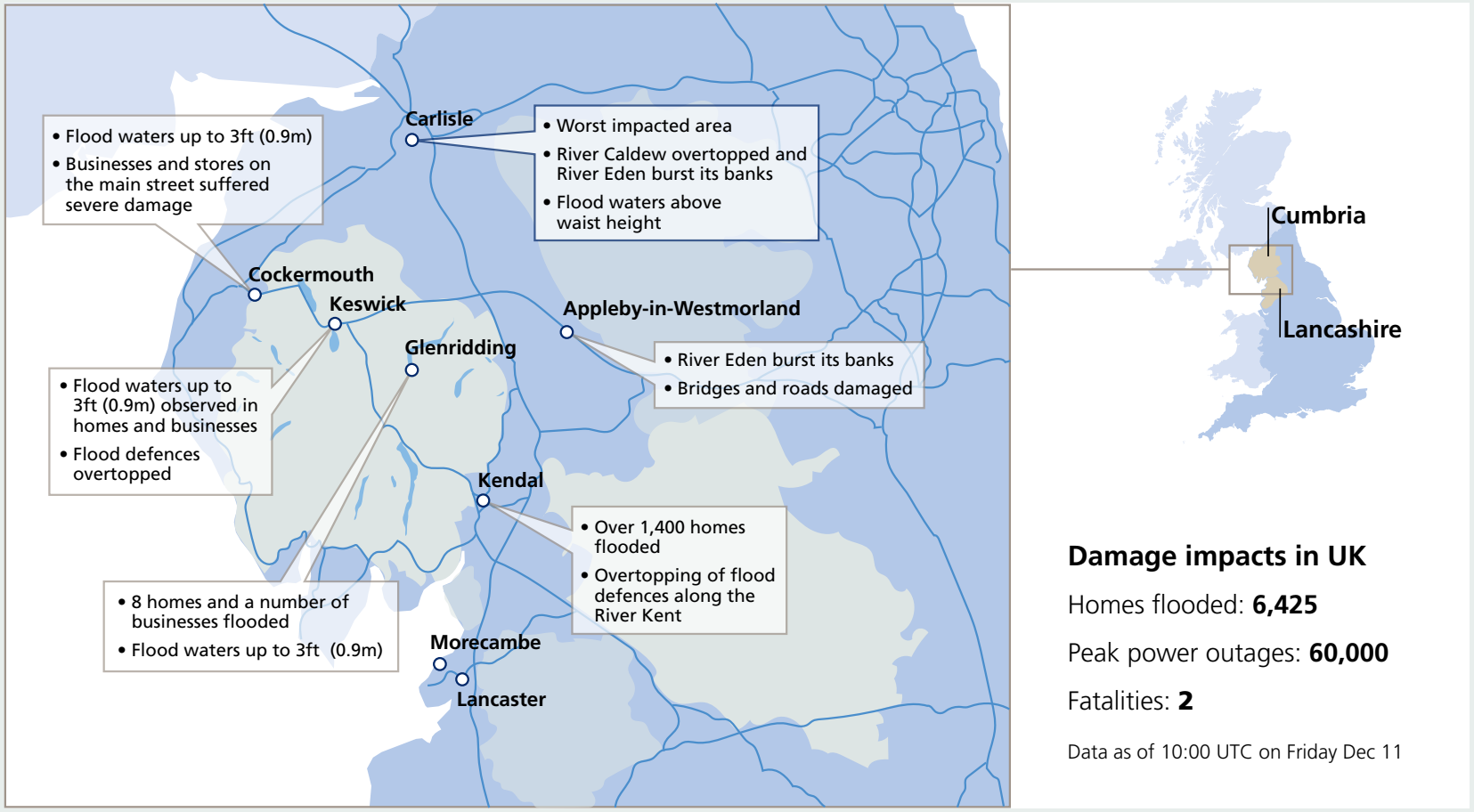


Figure 6. Areas worst affected by the flooding

Section 3 – What happened (continued)

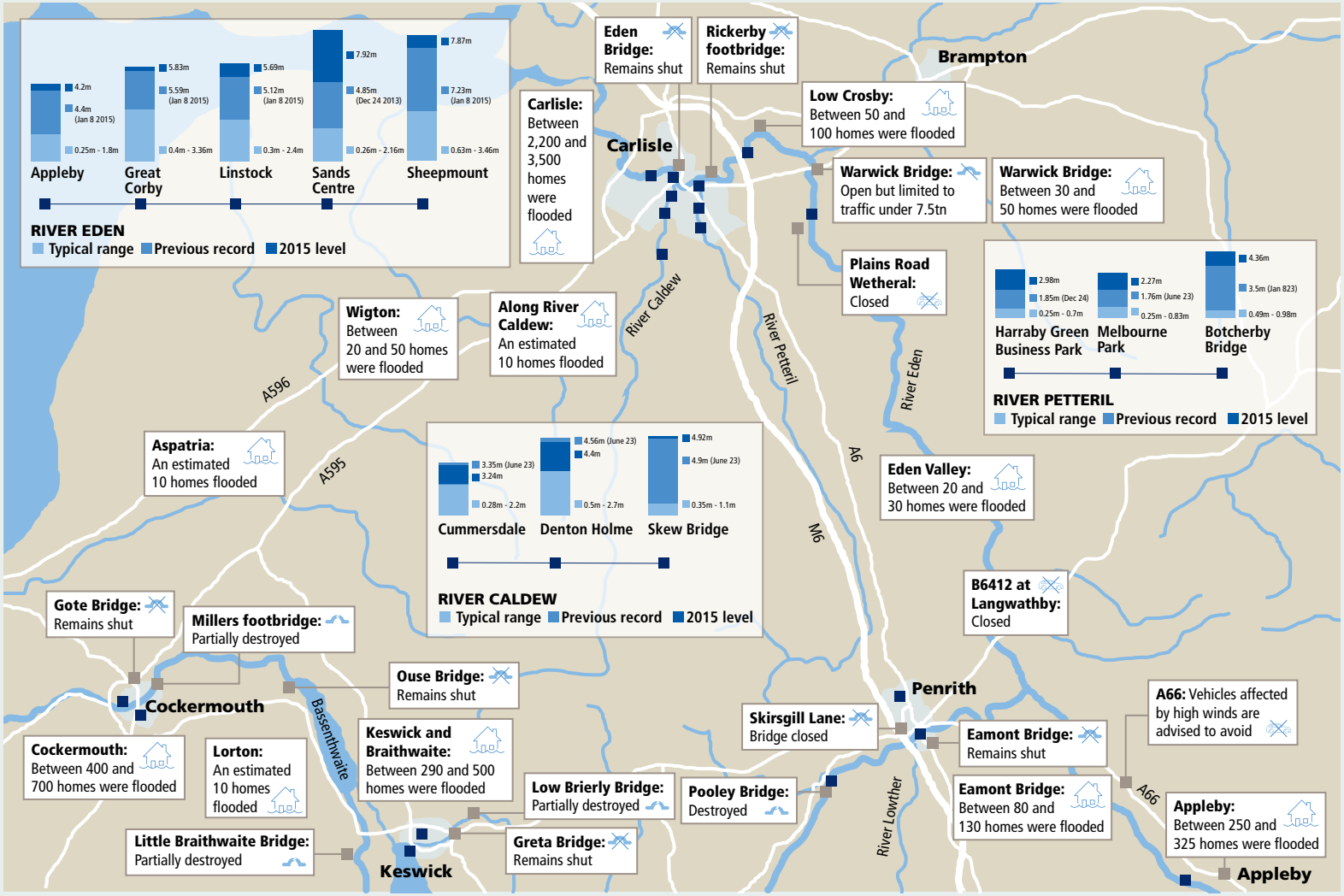


Figure 7. Areas worst affected by the flooding (Cumbria news).

Case study 2

A view from the National Flood Forum's recovery trailer

The charity provided support and advice to anyone affected by Storm Desmond and the subsequent winter floods, taking enquiries from residents during a 16-day tour of 20 flood-hit locations across the county.

A team of National Flood Forum staff undertook the tour in partnership with the Environment Agency, Cumbria County Council and local authorities who collectively spoke to an estimated 650 people who wanted to express their views and discuss their concerns following the floods.

The main difficulties for many people include: Dealing with loss adjustors (although many others also shared positive impressions), progressing their insurance claims, knowing what to do if they're uninsured and facing issues between tenants and landlords. A recurring theme about the shortage of independent surveyors to give impartial advice, particularly about how to stretch the £5,000 resilience grant to cover their needs, was also widely reported.

After the initial feelings of panic, shock and heartbreak about the damage to their homes and businesses, many people were slowly coming to terms with the realisation of being out of their homes for several months and the uncertainty of not knowing when they'll be able to move back.

Heather Shepherd, Community Support and Flood Recovery Specialist for the National Flood Forum said: "People want to take action to ensure their rebuild is progressing with a positive and advancing approach. All they want is to return to some sense of normality but problems with insurance, finance, builders, surveyors, grant processes, and the worry that the continuing rain will flood them again and take them back to square one proves a major issue and seriously hinders the rate at which they can get things done."

"People want to take action to ensure their rebuild is progressing with a positive and advancing approach."

Section 4 – Key Insights

In this section, we discuss the facts and our findings from the previous chapters. It is an interpretation and structured analysis of the key topics that were brought up during our interviews and field work with the affected communities and businesses, authorities and flood resilience experts.

Based on our recently published PERC manual and taking into account the Zurich Flood Resilience Alliance's insights gained over the years, we structure this analysis following our own unique approach to the resilience thinking.

Since 2013, the Zurich Flood Resilience Alliance has been developing a flood resilience framework. This framework helps to better understand the concept of resilience and how it can be applied to organise the key insights, strengths and weaknesses of an actor, a community or a given situation and what improvements could be made. For example, it is more cost effective to address the underlying problems that result in losses and distress during and after flooding, rather than simply alleviating the symptoms of flood disasters through post-event recovery. We look at a more holistic approach to resilience, understanding how communities can thrive and develop whilst managing flood risk.

There are many conceptual models available, we have chosen to combine two; the UK's Department for International Development (DFID) 'sustainable livelihoods framework' (SLF) and the Multidisciplinary Center for Earthquake Engineering Research's (MCEER) description of resilience systems to create our '5C-4R community-based flood resilience framework.' To clarify, the 5C stands for the SLF's five capitals, and the 4Rs comprise the four properties of a resilient system.

5C-4R flood resilience framework

The five capitals:

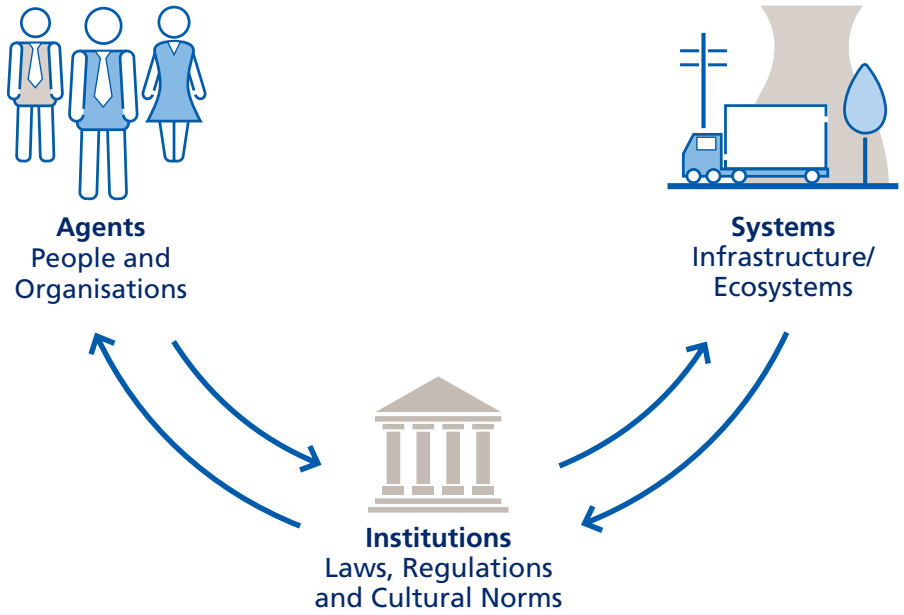
- **Human** (education, skills, health).
- **Social** (social relationships and networks, bonds that promote cooperation, links facilitating exchange of and access to ideas and resources).
- **Physical** (things produced by economic activity from other capital, such as infrastructure, equipment, improvements in crops, livestock).
- **Natural** (natural resource base, including land productivity and actions to sustain it, as well as water and other resources that sustain livelihoods).
- **Financial** (level, variability, and diversity of income sources and access to other financial resources that contribute to wealth).

The four properties of a resilient system:

- **Robustness** (ability to withstand a shock), for example, housing and bridges built to withstand a flood.
- **Redundancy** (functional diversity), for example, having many evacuation routes.
- **Resourcefulness** (ability to mobilise when threatened), for example, a group within a community that can quickly mobilise to convert a community centre into a flood shelter.
- **Rapidity** (ability to contain losses and recover in a timely manner), for example, quick access to sources of financing to support recovery.

Section 4 – Key Insights (continued)

The interacting components of a resilient system



The 5C-4R framework and our interpretation of resilience can be applied at various stages of the disaster risk management (DRM) cycle. When analysing the information from our research of the Cumbria floods, we conclude that the following insights are the most important to discuss and are therefore treated as our 'key insights'.

We discuss these structured around the DRM cycle, following the chronological order, which helps us explore where resilience is strong or weak during pre-event risk reduction, preparedness, intervention and coping, and during the reconstruction and future risk reduction action.

Section 4 – Key Insights (continued)

Corrective Risk Reduction

Key Insight: Flood Defences did not fail because of structural integrity and design, but they still overtopped. There is a heavy reliance on physical protection.
(Categories: Corrective Risk Reduction, Physical Capital, Robustness, Infrastructure, Enabling Environment)

Since the last major floods in Cumbria in 2005 and 2009, the Environment Agency has strengthened flood protection in the region for more populous areas, while other communities are without defences. This allows us to compare the risk awareness and resilience of people in 'defended communities' (i.e. with EA schemes, e.g. Carlisle and Keswick) and the communities with smaller scale or property level defences or areas with none at all (e.g. Kendal and, to some extent, Appleby).

In Carlisle, defences were upgraded to withstand the modelled 0.5% annual chance of flooding from the river Eden. In the December 2015 floods, some of these measures were effective – for example some areas in Carlisle were spared flood waters, but others still flooded even with the new defences in place. During the community drop-in sessions of the National Flood Forum, some individuals observed that they had been unaware of their residual flood risk and limitations of the flood defences. Interviewees described "a false sense of security" after the completion of the new defences and some expressed that they were "quite angry that millions were spent on defences that did not work".

The perception of the effectiveness of defences depends almost entirely on how respondents were impacted. Those that escaped flooding this time, but were affected earlier, judge them to be a success, but those affected this time raised more questions. According to some of the first responders who got a good feel for the disposition in affected areas, the Environment Agency is frequently perceived to be responsible for the success or failure of defences.

Key Insights: Corrective Risk Reduction

- Flood Defences did not fail because of structural integrity and design, but they still overtopped. There is a heavy reliance on physical protection.
- Local communities and interest groups can take action to drive flood protection.
- Community Flood Action Groups contribute positively.
- Old transportation networks are creating flood risk to communities and major disruption when they fail.
- The resilience discussion in the UK should be widened to include integrated flood risk management.

In Keswick there is a £6 million reinforced concrete wall topped by a 122 metre long glass panel as the main flood defences for lower-lying areas in the town, designed to hold back flood levels, such as those in 2009 where the river Greta rose to 4.6 metres. The wall overtopped in December 2015, when the river surged to 5.3 metres. In the absence of secondary lines of defence, the damage when flood defences are overtopped can be extensive. Even the Mayor of Keswick said: "The flood defences were designed for a one in 100 year event and it's six years since we had the last one, we were sort of surprised that we got one so soon." It appears that even the experts are confused; after the 2009 floods, residents were assured that it was "an exceptional flood" and drew the conclusion that it was "unlikely to happen again for many years", but a flood defence designed for a certain return period is still subject to failure or overtopping by larger events, which may occur at any time.

Section 4 – Key Insights (continued)

At the time of writing, there was no evidence of the Environment Agency's defences failing (i.e. they were not destroyed or broken by the flood waters) but they were instead overtopped, indicating the severity of the event. A good example is the self-erecting flood barrier, based on a Dutch example, built in Cockermouth. Stretching 120 metres, the £4.4 million project was launched after hundreds of people had to be evacuated from their homes in the 2005 and 2009 floods. The barrier worked fine for minor events, but was overtopped this time. However, a barrier that overtops but does not fail can still have a partial effect during such an extreme event, and some residents praised the work that saved their houses this time.

There is uncertainty around the design parameters of flood defences and whether they will really stand up in the event they were designed for, leaving residual risk for which alternative strategies are required. Individuals and other stakeholders consulted recurrently emphasised that there is a low level of awareness about residual risk in the community: Some property owners were not aware that the flood defences would not provide 100% protection. Taking residual risk into account when planning property defence strategies was considered to be a significant challenge however a viable strategy may be one of multiple defence lines, including the use of demountable defences, property level protection, adapted, resilient homes, ensuring personal safety and limited property losses by moving important documents and assets upstairs.

People in the communities of Appleby and Keswick reported a broader appreciation of flood risk. Aside from any flood protection schemes, these two communities also demonstrated a range of measures to enhance their individual protection levels. Business and homeowners alike in these communities reported to have taken adaptive measures such as raising socket levels, installing concrete floors or purchasing sump pumps to be better protected.

The view that flood defences are assumed to be fail-proof can leave communities and businesses vulnerable. In Carlisle a new Sainsbury's and Art Centre were built behind flood defences but were affected in the Desmond event.

In summary, physical defence measures are effective in reducing smaller, high frequency flood losses, but are unlikely to prevent losses in more extreme, rarer events and may even exacerbate problems. This leaves a need for additional protection, prevention and resilience measures in addition to physical flood defence in order to manage the total risk.

Key Insight: Local communities and interest groups can take action to drive flood protection. (Categories: Corrective Risk Reduction, Social Capital, Resourcefulness, Infrastructure, Community Control)

Affected communities often come together to form successful and democratic flood action groups.

In Cockermouth in 2011, the local flood action group took flood defences into their own hands, voting to increase local taxes to fund flood defence improvements. Businesses that had been unable to get the level of insurance cover needed and were out of action for months following the 2009 event had taken additional protection measures and were back up and running within days of the 2015 storm, highlighting the success of locally-driven flood protection improvements.

In South Yorkshire, a recent project involved 250 businesses contributing to a £19 million flood defence scheme[14] that otherwise would not have been able to go forward, improving the level of flood protection along an 8 km long stretch of the River Don.

[14] http://www.cockermouthfloodactiongroup.org.uk/

Section 4 – Key Insights (continued)

Key Insight: Community Flood Action Groups contribute positively. (Categories: Social Capital, Resourcefulness, Community Control)

Community Flood Action Groups play a pivotal role. These groups frequently form immediately after serious flooding, such as in Carlisle, as a means of highlighting local flooding problems as perceived by the community and lobby for action. However, the National Flood Forum noted evidence from across Cumbria and further afield that such community groups can often fall into decline and even disband only a few years after the flood and after some measures may have been put in place. The December 2015 floods have shown just how important it is that Community Flood Action Groups continue as part of an integrated flood risk management plan. They have a vital and ongoing role to play in order to manage residual flood risk, to help coordinate community action, to remain prepared and to be ready to take effective action as part of wider partnerships aimed at increasing community flood resilience.

Key Insight: Old transportation networks are creating flood risk to communities living near them, creating major disruption when they fail. (Categories: Corrective Risk Reduction, Physical Capital, Robustness, Transportation, Enabling Environment)

Cumbria is characterised by small settlements on narrow roads, often reached by old stone bridges, but these bridges are as much of a barrier to water as a way to cross it. Built in multiple spans with piers in the rivers themselves, they can impede the flow of water causing it to back up and overtop banks. Over 130 bridges were damaged or temporarily closed in the aftermath of Storm Desmond across Cumbria.

In Pooley Bridge, the flood became so intense that the bridge ultimately failed, leaving travellers with an additional 15 mile detour through narrow lanes. The loss of access is inconvenient for local residents, who need to commute to work in nearby Penrith, but the key economic activity of the village is tourism (accommodation, tearooms) and being cut off whilst a new bridge is built will have an ongoing economic impact for years to come. Other places fared similarly: The Keswick flood action group and other groups and experts suggest that a major improvement would be to replace the old multiple span masonry bridges with more resilient, modern structures.

Key Insight: The resilience discussion in the UK should be widened to include integrated flood risk management and not just property-level protection (PLP) and 'resilience' schemes. (Categories: Corrective Risk Reduction, Human and Social Capital, Resourcefulness, Infrastructure, Community Control)

Flood protection at site level can be successful and cost-effective, as demonstrated by the Penrith Police Headquarters. Following previous smaller floods, the site installed PLP in critical areas to enable flash flooding and quickly rising water to be channelled through openings on the site, towards the flood plain with minimal or no damage. Following this initial step, a larger defence element was added towards the lower part of the site, facing the flood plain of the Eamont. Had the flood levels been the same as 2009, the loss would have been nil this time, compared to significant damage back then. However, the defences were overtopped and eroded in some places, and significant damage to various areas and buildings was sustained from Desmond. This location serves as an excellent example to demonstrate the benefits of flood protection and how various aspects of flood risk management are coordinated to achieve integrated protection to avoid losses over a series of events of various sizes and severities.

Section 4 – Key Insights (continued)

Preparedness

Key Insight: Early Warning Systems are valuable – but they can be much more effective. (Categories: Preparedness, Physical and Social Capital, Rapidity, Education and Communication, Enabling Environment)

The provision of Early Warnings are part of the resilience efforts and are managed through the Environment Agency. Whilst there are general area warnings broadcast on TV and radio, and available via the internet, people can sign up to more focused local warnings via text messages or phone alerts. Defra and the EA have already increased efforts to improve the reach of their warnings, as described in their joint report 'Improving response, recovery and resilience – Science report SC060019'.

There were mixed reviews of the effectiveness of the warning systems in Cumbria. In Carlisle, where local government offices sustained considerable damage, warnings did not provide sufficient time to complete preparations and take emergency action to move valuable assets out of harm's way. Other public buildings fared better, and in some cases warnings provided enough advance notice to safeguard over £300,000 of assets.

The British Red Cross and other first responders acknowledged that the warnings allowed them to be in a high state of readiness to respond to the situation. Other cases, such as a large school, did not sign up to the EA warning system, so relied on broadcast warnings and messages from the local authority or even from colleagues. This meant that they did not appreciate the severity of the situation until it was almost too late. Evacuation of key equipment relied on the Facility Manager being available – had he not answered the phone, it is unlikely that they would have been able to reduce any losses on site.

The response at a local level varied by community: In Keswick, according to the Flood Action Group, the warnings helped to significantly reduce losses, allowing time to move vehicles and materials to safety, although they could have been better at forecasting timings of the onset and peaking of the flood, as well as the predicted flood height. In Cockermouth, the Flood Action Group felt that warnings came too late and failed to predict the eventual height and the timing of the peak of the flood waters. This affected people's ability to make good decisions to safeguard property and reduce losses.

Overall people felt unprepared for flooding, possibly indicating a prevailing perception that physical defences cannot fail. In many cases, these locations had no formal or even informal flood emergency plans in place. They were either not registered or did not give enough credence to Environment Agency flood warnings. In both areas with recent flood defences (Carlisle and Keswick) and smaller scale defences or areas with no defences at all (parts of Kendal and Appleby), some people found themselves unprepared and took action too late (i.e. not being able to move their belongings in time) or found themselves unable to do so during the emergency (e.g. comments like "the stairs were too steep and narrow" or "we were away when Desmond struck and our emergency plan did not account for measures taken in our absence").

Key Insights: Preparedness

- Early Warning Systems are valuable – but they can be much more effective.
- Lessons learnt from past floods have been applied and had a positive effect.
- Repetitive flood events are not considered enough in the preparation scenarios.
- Collective disaster memory is short.

Section 4 – Key Insights (continued)

Key Insight: Lessons learnt from past floods, especially the coordination of the intervention organisations, have been applied and had a positive effect in the 2015 floods. However, repetitive flood events are not considered enough in the preparation scenarios.
(Categories: Preparedness, Social Capital, Rapidity and Redundancy, Communication, Enabling Environment)

There was a well-established and well-coordinated multi-agency response (Cat I and Cat II) in Cumbria, including the British Red Cross acting as an auxiliary to the official public sector agencies. The mandate of the British Red Cross is to be part of the local resilience forum (LRF), a multi-agency response coordination group who help category one and category two responders work together. The coordination effort was deemed a success as groups worked well together, leveraging existing personal relationships, for example holding proactive teleconferences to manage the incident.

Nevertheless, response resources were stretched, due to Desmond affecting such a geographically large and some relatively remote areas, and subsequent events (Eva and Frank) following so closely. There was a chain of events this time and Storm Eva following Desmond led to a temporary suspension of the emergency response to restart the preparedness process. This was frustrating for those affected and lessons could be learnt to ensure that there is a smoother transition between the immediate emergency response and the longer-term recovery phase.

Key Insight: Collective disaster memory is short.
(Categories: Preparedness, Human Capital, Resourcefulness, Education, Community Control)

Memories from previous floods are often forgotten; despite communities in Carlisle suffering repeated flooding, people and businesses forgot about simple loss reduction measures such as moving valuables upstairs.

Even larger businesses who have taken action following previous floods weren't necessarily better prepared. For example, an industrial location in Cockermouth, repeatedly hit by flooding took physical measures to try and prevent future losses. In the 2015 flood, they were able to contain some property and business interruption losses, but still sustained a large blow, relying on a single line of prevention that did not prove to be effective.

Section 4 – Key Insights (continued)

Intervention and coping mechanisms

Key Insight: Social support networks are critical in handling the event from an individual perspective of the affected families, but there are socially vulnerable people left out. (Categories: Coping, Social Capital, Robustness, Community Control)

The people and businesses of Cumbria were praised for their community spirit in the aftermath of the event; parents helping their children, sons and daughters helping their parents, neighbours helping each other and total strangers volunteering time or providing food and drink in times of distress. Most people seemed to have a relatively clear plan on how to recover and get back to normal, but this is not true for everybody. Donations – over £1 million was collected in the first week after the flood – and important volunteering networks such as the local churches, can alleviate some of the worst, but there is a long-term struggle for unmet needs that must be addressed. Some people want to leave for good because they feel nothing can be done to protect them at their home, but it is unclear how they will be able to do so.

Many elderly people were flooded, both in care homes and in their own private homes, often in vulnerable locations in historic houses that need a lot of time and care to dry out and restore. During this recovery time, these people are completely removed from their familiar environment, causing additional personal and social distress with ripple effects throughout their families and their care personnel. Furthermore, repeated severe flooding is eating away at people's resilience and willingness to cope. A number of families were flooded for the third time (2005, 2009 and 2015) and expressed a feeling of despair, of being distressed and unwilling to keep fighting the water. For many, the floods have created psychosocial effects, like "feeling sick every time it rains" and worrying that they "will never be able to sell our house profitably as planned", these impacts are not prominent in the flood resilience discussion.

Key Insights: **Intervention and coping mechanisms**

- Social support networks are critical, but there are socially vulnerable people left out.
- Protecting critical infrastructure and avoiding cascading failures has worked, but more needs to be done for those where a single critical failure point caused chaos.
- Large floods have a devastating ripple effect through affected communities. Better emergency planning is required to help avoiding cascading effects to society.
- The recovery process is based on narrow instructions that sometimes fail to provide the expected services at reasonable cost.
- There is an opportunity to use the recovery process to correct existing risk through 'resilient reinstatement' or 'building back better' approaches, but mechanisms facilitating or incentivising this are lacking.

Key Insight: Protecting critical infrastructure and avoiding cascading failures has worked in some locations, but more needs to be done for those where a single critical failure point caused chaos and a few 'big near misses'. (Categories: Coping, Physical Capital, Robustness, Infrastructure, Enabling Environment)

There were a number of cascading failures from the loss of critical infrastructures, such as key road and rail connections, the loss of power due to a flooded substation, the combined loss of water, power, phone and transport connections when bridges were destroyed, and the delay of critical services to the population due to the loss of, for example, a city civic centre. Despite resilience measures being in place following previous flooding, infrastructure was still affected by the 2015 floods. The transport network was critically affected and experts highlighted this was more than an inconvenience and there was a significant effect on emergency intervention with rescue efforts being hampered in terms of speed and efficiency.

A key player in the flood response network in an emergency are 'Gold Command Centres' coordinated by police stations. Due to their importance, Gold Command Centres are subject to a continuous process of improvement in the protection of the site, including flood gates and internal/external flood doors being installed. In the 2015 floods, staff at the Cumbria Constabulary office in Penrith reported flood levels as being the highest they had ever seen. Additional sandbags were deployed to critical installations on site at the last minute which allowed this centre to continue to function, however a power substation came close to failure and the Occupational Health and Safety department was damaged. This is one example of a 'near miss' that could have caused cascading problems had it flooded and thus been unable to provide the essential services it needs to provide in crisis times.

Another example of cascading failures is Lancaster, where despite there being limited impact on properties, there was a bigger impact on power distribution from a substation, which led to ripple effects through society. The critical substation, which had been identified as flood prone but not given high priority and so inadequately protected, was taken offline in order to manage the situation and avoid a failure. These meant parts of the town were without power which affected businesses and the entire community, even those that did not directly flood. Moreover, the deployment of generators and other supporting equipment left the rest of the country more vulnerable should a power failure occur. Communication and traffic infrastructure were also affected, with mobile networks and traffic signals down and it was unclear to people how long this situation would continue. Additionally, the main supermarket was flooded and shut and some panic buying took place and with cash machines out of order, people could not get money. Whilst less direct flood damage was experienced than in Carlisle and Kendal, this infrastructure failure demonstrates the ripple effects through society.

Key Insight: Large floods have a devastating ripple effect through affected communities. Better emergency planning is required to help avoiding cascading effects to society. (Categories: Coping, Social Capital, Robustness and Resourcefulness, Emergency Planning, Community Control)

A total of 44 schools in Cumbria were closed as a result of flooding[15], with approximately 75% of the pupils flooded out of Carlisle schools. As pupils were sent home early for the Christmas break, parents either needed to stay home or arrange childcare. The ripple effect impacted the entire region, affecting people indirectly that were far away from the actual flood event itself. Large organisations providing essential community services, such as schools, have not yet established business continuity plans to continue school curriculums in case of events that prevent them from using the school building or where students cannot come to school.

[15] The Cumbria News

Section 4 – Key Insights (continued)

Key Insight: The recovery process is based on narrow instructions that sometimes fail to provide the expected services at reasonable cost. (Categories: Coping, Financial Capital, Resourcefulness, Community Control)

It was highlighted that some contractors were often found not to have the specialist knowledge required to support the recovery process, in particular, contractors helping with the drying of the wet building envelope.

For example, in Cockermouth some contractors lacked the expertise to conserve, especially in older properties, and instead resorted to "ripping everything out". Additionally, despite the acknowledgement that there is an increased cost of working during these catastrophe periods, there is a concern that some contractors are overinflating costs of work during the recovery process.

Key Insight: There is an opportunity to use the recovery process to correct existing risk through 'resilient reinstatement' or 'building back better' approaches, but mechanisms facilitating or incentivising this are lacking. (Categories: Recovery and Corrective Risk Reduction, Human and Financial Capital, Community Control)

At the moment, there is still a tendency to build back rather than 'build back better' or build forward. Currently, due to lack of incentives, absence of procedures and time and cost elements, replacements are often made like for like, i.e. the same timber floor or the same location for electrical installations. This leads to the same level of risk should a flood occur again in the future, missing the opportunity to avoid the repetitive loss. There have been some positive steps forward to consider resilience-building, but clearer processes to further this are needed.

There is a lack of awareness or knowledge of the opportunity during the reinstatement period to 'build back better'. Based on the activities of the National Flood Forum, we have seen that Flood Fairs can be a good opportunity to inform and support the population about what is available and what qualified work would look like. This allows people to make informed choices about, and assess the work of, contractors and builders. Jointly held flood fairs held or moderated by unbiased organisations like the National Flood Forum can objectively showcase flood repairs, resilient reinstatement and future protection and prevention opportunities. These fairs should be much more institutionalised and replicated on a larger scale.

'Resilient reinstatement' and 'building back better' not only applies to individual homes and businesses, but also to larger infrastructure. There are especially important questions around the historic bridges that failed – where there are feelings by local residents and experts that they should not be reinstated in their previous form. Rather, there should be a modern yet suitable construction that neither is affected by future flooding nor increases the risk downstream due to changes in the effective channel cross-section. However, there is an issue with available resources, as the local council feels the damage to the road infrastructure is beyond what they can address on their own.

Section 4 – Key Insights (continued)

Prospective Risk Reduction

Key Insight: The terminology of a '100 year flood' is so misleading it causes more problems than it solves. (Categories: Prospective Risk Reduction, Human Capital, Robustness, Education, Enabling Environment)

Part of the answer lies with the way in which risk is communicated. We currently still look at and talk about 'return periods' and '100-year events' too much. It is clear from the public reaction that there is a misunderstanding about what this terminology means.

Building knowledge and understanding of flood risk needs to be embedded. Local school staff highlighted the importance for them of building risk and resilience knowledge into the curriculum so that it stayed within the local community. In Carlisle there is a relatively stable local population so building knowledge from schools flows into longer term community knowledge.

Key Insight: Various actors need to come together to achieve a more integrated concept of flood risk management. (Categories: Prospective Risk Reduction, Social Capital, Redundancy, Government regulations, Enabling Environment)

Flood risk management is a task that involves many actors and is not just the job of the government's dedicated Environment Agency. More public functions (such as the education sector) need to come together with the population, local businesses and with large organisations to achieve integrated flood risk management.

As we have seen, flood risk is a complex topic and there is not one single solution or actor that can solve the problem.

Key Insights: **Prospective Risk Reduction**

- The terminology of a '100 year flood' is so misleading it causes more problems than it solves.
- Various actors need to come together to achieve a more integrated concept of flood risk management.
- Community Engagement has a positive impact throughout the entire flood event.
- There is limited uptake of the £5,000 resilience grant and a lack of independent advice on how it should be used.
- The new insurance mechanism 'Flood Re' could help in future risk reduction, but people need more clarity and need to feel more comfortable with the mechanism in order to make it work.

Part of the findings from our interviews reveals two aspects that need addressing:

1) The lack of understanding and/or appreciating the residual risk at any given location.
2) Following from there, the extent to which the public does or does not take up the role it could play to address the risks they face from floods.

If large-scale flood barriers have been erected by the Environment Agency, according to the Carlisle authorities, residents believed in the absolute safety of them and rarely took their own protection – a view echoed by staff at the schools. When people did take action, as reviewed after Property Level Protection schemes were completed in the past, they would rarely go beyond what could be financed with the £5,000 grant even in cases where a little extra contribution would have been enough to achieve an acceptable level of protection for a specific property.

Key Insight: How other, private sector actors can play a role to further the integrated flood risk management concept. (Categories: Entire DRM cycle, Social Capital, All 4Rs, Social Cohesion, Community Control)

There are also good examples highlighting where other actors could play a role to influence flood risk, such as hydropower generation companies and owners of artificial water bodies and reservoirs. Members of Flood Action Groups commented on the role that reservoirs and dammed lakes could play in alleviating flood peaks: "There is a regulation from government in place for droughts on reservoirs, but not for flood, which is also needed. We want a statutory regulation for water utility companies to take flood risk into account in reservoir management."

This is a practice that is established in a few countries including Switzerland[16], where water is released from the lake ahead of the predicted flood in order to create space for the excess water during the rainfall event and thus break the intense flood peak. Such measures need to be organised and agreed with owners of these dams/lakes and potentially compensation schemes devised. This is one of many measures that will become increasingly important under climate change adaptation strategies.

While there is UK legislation and appropriate regulatory bodies looking at managing flood risk originating from reservoirs[17], we are not aware of a regulation that helps alleviate flood peaks through the multi-purpose use of such reservoirs.

Key Insight: Community Engagement has a positive impact throughout the entire flood event. (Categories: Entire DRM cycle, Social Capital, All 4Rs, Social Cohesion, Community Control)

In statutory terms, responsibility for handling flood emergency situations lies with specific authorities, such as local government and the Environment Agency. However, outside of this preparedness and response field, community groups have emerged – the Cockermouth and Keswick Flood Action Groups being prime examples, formed with guidance from the National Flood Forum. The opportunity exists to integrate these more closely with the statutory agencies to join up thinking about flood management.

The social impact of floods is often missed when dealing with the aftermath of flooding. For example, the Property Level Protection scheme is wholly focused on physical infrastructure improvements. Whilst this is valuable, resilience of a community is not simply a matter of dry or wet-proofing properties. The ability of a community to continue with their lives relies on the interplay of multiple factors beyond protection of physical infrastructure.

By enhancing the focus on community voices – looking to build support through community cohesion and better knowledge sharing mechanisms – many losses could be avoided. It could also help to ensure that better understanding of risk is developed which in turn can help communities decide to take appropriate actions.

Local knowledge is also needed to help agencies coordinate and plan appropriately. Knowing that floods will effectively cut one side of town off from the other in Keswick helps planners decide on the location of emergency operations, but this could be improved with more coordination between community groups and the emergency planning agencies.

Flood resilience needs to be viewed holistically, utilising community assets (knowledge and experience) to harness environmental and physical developments that enhance the ability to manage floods.

[16] https://www.swv.ch/Dokumente/Artikel-SWV/Gastbeitrag-NZZ-WK-und-HWS_August-2014.pdf;

[17] https://www.gov.uk/guidance/reservoirs-owner-and-operator-requirements#prepare-a-reservoir-flood-plan-and-flood-map

Section 4 – Key Insights (continued)

Key Insight: There is limited uptake of the £5,000 resilience grant and a lack of independent advice on how it should be used. (Categories: Entire DRM cycle, Social Capital, All 4Rs, Social Cohesion, Community Control)

The UK Government is providing property owners up to £5,000 for flood resilience measures. However, independent advice for each property on how best to spend that money is still needed. Certain Flood Action Groups held flood fairs after the 2009 floods with bodies such as the National Flood Forum presenting to people what is available to protect themselves more. Currently, however, it is still felt that homeowners are at the mercy of salesmen in the end and lack enough independent advice how to best come to a decision which measures to take.

Many experts believe that the insurance company's surveyors have a role to play in future post-flood assessments to not only assess losses, but also provide advice on strategies to reduce the damage next time. Where such resilience repair can be made cost-neutrally to the claim, it could obviously be included in the reinstatement process. For anything above and beyond the individual claim, the resilience grant scheme would apply and should be sought out. However, queries of the National Flood Forum with residents and by Zurich across 180 different flood claims highlighted that the uptake of the grant is mixed at best. Customers have received guidance from the loss adjusters about the availability of the flood resistance / resilience grant and discussed various options with them. Despite this, the take up of customers applying for grants to their local authority to fund additional measures has been low, for the following four main reasons:

Complexity: Residents do not understand the application process or found it too complicated and not user-friendly, involving a lot of paperwork. There was also lack of coordination and clarity on how the process worked and who is eligible to apply and people mentioned "everything was all rather complicated."

Timing: The repair process was found to be delayed by the application process, increasing cost such as alternative accommodation, which would likely outweigh the benefit of the grant.

Funding: Some up-front funding was found to be necessary by applicants, which was difficult to justify during the flood emergency situation. Also driven by the need to reinstate now and not wait until applications proceeded successfully, affected people were reluctant to self-fund and seek reimbursement from the local authority afterwards.

Aesthetics: People found the suggested solutions highly unattractive that would, for example, increase the flood water resistance of internal materials, including plastic finishes, tiled floor and stainless steel kitchens.

The likelihood of repeat flooding was perceived as too low to take action: Some reported this was the first flooding event in 80 years so property owners do not feel the same urge to look at resilience measures as elsewhere, where repeated flooding has already occurred.

Key Insight: The new insurance mechanism 'Flood Re' could help in future risk reduction, but people need more clarity and need to feel more comfortable with the mechanism in order to make it work. The risk reduction element needs to be made more explicit. (Categories: Prospective Risk Reduction, Financial Capital, Robustness, Risk Transfer, Enabling Environment)

Flood Re is a 'flood re-insurance' scheme devised by the Government and the insurance companies to help support households at highest flood risk (**www.floodre.co.uk**). The scheme, which went 'live' in April 2016 allows insurance companies to pass on the flood risk element of eligible home insurance policies in return for a premium for each policy, based on the property's council tax band. It is estimated that insurers will pass on the flood risk element of buildings, contents or combined home insurance policies for around 350,000 households.

In the immediate aftermath of Storm Desmond a number of people interviewed felt Flood Re was too complex and needed to be consistent in the coverage and adequacy of risk assessment. They did not know which flood maps to consult to determine locations at 'high risk'. It is not for businesses, not even for small guest houses, which may cause difficulty in getting insurance cover on a private home operating a mini-business, and it is limited to cover a property sum of £350,000. While much of this lack of clarity can be assigned to the fact that Flood Re was not in effect and available at the time of Storm Desmond more can and is being done to ensure those in high risk areas are aware of the details of the scheme, how they can access it and importantly what they can do to mitigate their risk.

It is intended that Flood Re will only operate for 25 years, in theory allowing time for the Government, local authorities, insurers and communities to become better prepared for flooding. This could mean, for example, making use of better land planning, sustainable drainage and development and effective flood risk management. It is also anticipated that when the scheme ends there will be a more accurate system of risk reflective pricing for home insurance prices. There is, therefore, an incentive for homeowners, local authorities and the government to take action to try and mitigate the effects of flooding.

Also, some Flood Action Groups felt the 25 years was too short a period of time to have a long term material effect on pricing. Although Flood Re has a transition document for publication, there seems to be a need for explicit planning to build in risk reduction and adaptation. Currently, there is a pure discussion around insurance rates and insurance mechanisms. The potential for inconsistency of risk assessments in the light of new developments, especially flood defences, were felt not to be sufficiently taken into account. This may reflect the fact that the role of Flood Re may not be immediately visible to the policy holder, given that it operates as a reinsurer. There is also concern at the lack of an effective solution for small businesses particularly in the Lake District area, where people especially feel that a solution must be found for bed and breakfast-type businesses that fall under the Flood Re business exclusion clause. This has not been lost on the industry or Government who are pursuing a framework to act as an alternative to calls from other sectors for an intervention in the market that would create a cross-subsidy for businesses. There is also a clear need for SMEs to better understand and mitigate their flood risk exposure, the grants for flood resilience measures and the Government backed approach for risks unable to find cover in the commercial market.

Section 5 – Recommendations

5.1 Recommendation: To help individuals and communities who currently benefit from flood defence and alleviation schemes better understand and reduce their residual flood risk.

Recommendation: To help individuals and communities who currently benefit from flood defence and alleviation schemes better understand and reduce their residual flood risk

- Improve communication to raise, build and maintain individuals flood risk awareness and to encourage community ownership and action as a first step.
- Implement and integrate an effective community early warning system.
- Improve the language from the '100 year flood' to one that illustrates the level of risk and the consequences for individuals and communities.
- Build second and third lines of physical defence to avoid reliance on one measure.
- Avoid the build-up of additional risk.
- We need to work together, across sectors and hierarchies, to implement practical flood protection systems.
- Provide incentives that acknowledge taking prospective prevention efforts.

Defra formed a flood resilience taskforce which met for the first time in February 2016. One of the key work streams of this group focuses on the creation of a 'one-stop internet shop' for both households and businesses to provide access to relevant flood information.

The Centre 4 Resilience 'One-Stop Shop'[17] has been created and serves as a guidance web portal which is designed to allow different audience types to easily access relevant flood guidance information. This website is designed to be impartial, drawing specific reference to assistance available from the government and local authorities.

The website includes pages providing detailed step-by-step guidance on what to do before, during and after a flood event as well additional information on grants and subsidies available and property level protection measures.

The Defra flood resilience taskforce continues to develop this 'one-stop shop' whilst building awareness of the role of insurers in leading discussions with customers on resilient repair and the availability of government resilience grants.

Closely aligned with the 'one-stop shop' is the Defra roundtable's effort to encourage businesses to consider installing resilient measures in order to be better prepared for flood events and to ensure they minimise the impact on their business. A working group has been convened to examine this closer with work currently at an early stage. The group is assessing how to convince SMEs to invest in initiatives designed to make their premises flood resilient whilst also presenting the business case for doing so.

[17] http://www.centre4resilience.org/

Recommendation: Improve communication to raise, build and maintain individuals flood risk awareness and to encourage community ownership and action as a first step

Effective communication should aim to:

- Raise individuals awareness of their residual flood risk and the measures available to mitigate it
- Encourage the community to become actively engaged with authorities in managing flood risk through the establishment of a flood action group.

Individuals are eager for informed advice on their personal flood risk and would benefit from simple and clear, impartial guidance on the different property-level protection products, and different grants and funding that is available. They also benefit greatly from understanding their community's preparedness and emergency response measures, and what they should do in the event of a flood to protect lives and property.

The establishment of a flood action group can provide community support and be a conduit for the community's perspective on government-driven risk management measures. The group should prepare a flood action plan to capture actions the community should take before, during, and after a flood event.

The importance of not becoming complacent about residual risk will need to be communicated on a regular basis, to support individuals, communities and organisations in maintaining awareness and to avoid becoming less prepared for a flood over time.

It is important to point out that both producing better targeted warnings and improving the risk perception to motivate action are not new findings but were already made in the EA's Science report SC060019 (Work package 1: More targeted warnings).

However, it has been shown in past disasters that knowledge about risk and potential actions does not automatically mean such action is taken – there must be incentives and best practices available that can easily be taken up, are sustainable and replicable.

Recommendation: Implement and integrate an effective community early warning system

The effectiveness of an early warning is predicated on the presence of a well-functioning early warning system.

An early warning system is more than just the presence of an early warning – it is a fully integrated social and institutional network which expects, understands, trusts, and acts upon these warnings.

The system, to reduce the risk to life and property, should integrate:

- Forecasting and measuring what is happening in the physical environment (from rainfall to runoff in the rivers)
- Disseminating the warning, explaining what it means and what action is appropriate and safe to take.

Recommendation: Improve the language from the '100 year flood' to one that illustrates the level of risk and the consequences for individuals and communities

Quantitative statements about risk, especially return periods, can be misinterpreted.

We need to acknowledge that the '100 year return period flood (y RP)' is by absolutely no means 'low risk' and that both language around this as well as illustrations of what the consequences mean need to change.

If one lives in a 1% annual chance (which is an alternate expression for the 100 year return period) flood zone, one's risk will depend on factors such as whether:

- adaptations have been made to increase building resilience
- the consequential loss will be very low
- a property could be totally destroyed.

Are we willing to accept these consequences? There is a lot of awareness-building needed around the frequency and severity of flood events. We advocate better ways to illustrate risk, see the following example:

'Your new house has an expected lifetime of 50 years. If you live in a 50 year return period = 2% annual chance flood zone, this means there is a 64% chance you could experience this flood event in that 50 year timespan, and it will cause significant damage and loss to you and your house if it happens. Are you willing to accept that?'

Such an illustration would show much better that a 1% annual chance of flooding in an expensive house is actually high risk compared to other perils (for example, fire or windstorm damage).

Recommendation: Build second and third lines of physical defence to avoid reliance on one measure

Physical defences can fail or become overwhelmed, as in Carlisle. What happens in such an 'overload case', i.e. when the structure is exposed to a 1-in-100 year (or worse) flood? Will it fail? Will it remain structurally intact but overtop? Will it provide some remaining protection and buy time?

We recommend against relying on a single line of defence, and to ensure there are secondary (or more) lines of defence available.

Communities need to have a flood protection hierarchy in place that links:

- natural solutions such as natural flood plains and upstream retention space
- physical, permanent, large scale engineered solutions
- individual location specific and temporary, demountable protection.

Experience shows that temporary protection systems in particular can be subject to failure, as they often need human intervention and actions laid out in an up-to-date, practiced emergency plan, which can be missing or not updated regularly enough. Therefore we advocate for integrated multiple lines of defence that work together to provide maximum flood protection at affordable cost and often with additional (non-monetary) benefits.

Recommendation: Avoid the build-up of additional risk

Flood protection systems (taking into account the multiple-defence line approach) should be built and maintained to protect existing risk that otherwise cannot be mitigated.

However, new risk must not be created in flood plains and other high-risk areas, even when they are protected to current standards. It must be feasible within current legislation and practice, to forbid new development on flood plains. This is especially critical in view of Flood Re and future insurance solutions where buildings constructed after 2010 are not eligible to benefit from the scheme i.e. newly built, high flood risk property is not eligible for subsidised flood protection and will need to bear the full risk-based cost. In addition, the build-up of critical infrastructure in flood zones increases the complexities of cascading failures. Losses in the Cumbria event originated in recently completed public and private buildings which highlights that the current implementation of planning policies is inadequate.

Recommendation: We need to work together, across sectors and hierarchies, to implement practical flood protection systems

We believe that total risk can even be increased if flood defences are assumed to be fail-proof and assets are increasing on the 'safe' floodplain.

We have also discussed how difficult the uptake of flood resilience measures is, irrespective of whether they are sought proactively or are implemented during the reinstatement phase, and irrespective of whether they are recommended by the loss adjuster or the insurer and/or incentivised by government or other grants.

We should recognise that governments or institutions alone cannot offer complete protection to communities, and that everybody who is at risk from flooding needs to actively contribute their share – in terms of protection, risk avoidance, behaviour, in short: along the full risk management cycle – to achieve a practical and fully integrated flood risk reduction strategy. If we fail to do this the trend for increasing losses from flooding will continue.

Spatial protection can be used to protect existing risk efficiently for high-to-medium frequency flood risk (e.g. up to the 1% or 0.5% chance as cost-efficient and practically feasible), but residual risk needs to be managed in addition, often at the individual (household) level or through interest groups (through the support of Flood Action Groups, for example).

Incentives to increase the uptake of these additional measures must be created, including from governments financially, through awareness raising and educational measures, and as well by the insurance industry. We hope that the concepts of Flood Re to reduce flood risk, and to return to market premiums that adequately reflect residual flood risk that is acceptable and manageable, can support this. Furthermore, the build-up of additional risk must be discouraged by not building more assets inappropriately behind defended flood plains or making new spaces that are at flood-risk legally fit for development.

Recommendation: Provide incentives that acknowledge taking prospective prevention efforts

Previous reviews have shown little incentive for property owners to find/install PLP measures from an insurance or financial point of view, the driver for action is usually repeated flood events.

Research conducted by the National Flood Forum in 2013-14 has shown few examples of insurers recognising the lower risk and expected reduced losses from installing PLP or taking other measures – currently the main incentive is peace of mind.

It is unclear whether Flood Re could act as a better incentive in the future: i.e. installation of PLP measures becoming a requirement and condition of remaining in the Flood Re pot.

"We should recognise that governments or institutions alone cannot offer complete protection to communities, and that everybody who is at risk from flooding needs to actively contribute their share."

5.2 Recommendation: To address the risk from cascading failures and long-lasting ripple effects in society caused by damaged road and rail transportation networks, power outages and the like

Recommendation: To address the risk from cascading failures and long-lasting ripple effects in society caused by damaged road and rail transportation networks, power outages and the like

- Identify critical failure points in lifeline systems such as power distribution or road and rail transportation, develop scenarios to avoid cascading failures, and build a robust network along the four elements of a resilient system (4R).
- Encourage local communities to organise themselves to build interest groups that take action for innovative and effective flood protection.
- Take account of the full spectrum of flood resilience, using practical but wider-reaching frameworks such as our 5C-4R framework, instead of property-level resilience schemes alone.

Recommendation: Identify critical failure points in lifeline systems such as power distribution or road and rail transportation, develop scenarios to avoid cascading failures, and build a robust network along the four elements of a resilient system (4R). Include near-misses and other lessons learnt to identify where hidden critical failure points lie to anticipate their failure potential and protect them for future events.

The risks of cascading failures can better be taken into account by lead Flood Authorities, Risk Management Authorities and by Local Resilience Forums and their partners. There is a requirement for all parties to work in partnership, including infrastructure providers such as those managing the road network, to integrate critical system functionality into flood risk management.

One of the problems in Cumbria is the terrain and remoteness of some communities, and thus the need for a relatively lengthy road network including many old and historic bridges. In short, there is a lot of infrastructure at risk and it is always a question of priority and feasibility what can be protected up front and what cannot be.

Network providers need to acknowledge this is a problem and offer solutions as to how infrastructure systems can be managed as part of an integrated approach to flood risk management through the local lead Flood Authorities. Such approaches were already identified in the Pitt review in 2007 but recognising this, planning and implementing is still a timing and resourcing issue.

Recommendation: Encourage local communities to organise themselves to build interest groups that take action for innovative and effective flood protection

Community Flood Action Groups have a vital role to play both pre and post flood events. They are often built around a number of flood wardens originally established to communicate flood warnings.

Whilst groups may be set up as an immediate reaction to a flood that happened, for example as a protest or lobbying forum, they can and do also take on an important role as a link between the community and risk management authorities.

A well organised and enthusiastic group can:

- act as, in effect, a fourth emergency service provider whereby residents are galvanised into taking responsibility for their local community and undertaking local flood maintenance checks in conjunction with the local authority
- help coordinate individual and local community emergency action plans, providing much needed self-help and care for vulnerable neighbours

Support, advice and encouragement is provided by the NFF and EA and should continue to be provided to ensure such vital groups are maintained and continue rather than disband once the immediate goals are achieved.

Recommendation: Take account of the full spectrum of flood resilience, using practical but wider-reaching frameworks such as our 5C-4R framework, instead of property-level resilience schemes alone

Resilience is much more than protecting just one's physical property. The discussion needs to move beyond the notion that resilience consists of dry-proofing or wet-proofing an individual property.

While we acknowledge the importance of property-level protection schemes and the need to avoid and reduce direct financial flood losses, we need to take stock of the wider resilience discussion and frameworks available.

Ultimately, resilience is about the ability of a society or community to maintain or return to its development path, achieving their desired goals while managing disaster risk in a mutually reinforcing way. Doing so requires acknowledging the importance of intangible and/or psychosocial effects, which have a significant impact on peoples' lives and must be more prominently included in the flood resilience discussion.

As an example, approximately three quarters of pupils were out of school during the floods in Carlisle, which equates to a large number of teaching hours for individual students lost. Flood resilience in the local school system thus would go beyond the physical loss of the school building. Flood resilience is about being able to continue with education services and minimise school time lost through a variety of measures including alternate locations, remote teaching plans, homework, and utilising open air teaching methods where appropriate.

5.3 **Recommendation:** To improve flood preparedness

Recommendation: To improve flood preparedness

- Make Early Warning Systems more specific so they can perform more effectively.
- More demanding flood scenarios such as repetitive flood events need to be considered when looking at the deployment of emergency and recovery resources.
- Make the transition between coping and recovery smoother.
- Learn about and utilise better alternatives to sand bags.

Recommendation: Make Early Warning Systems more specific so they can perform more effectively

To allow for increased alert times and thus more loss avoidance, early warning systems and the services they operate on need to improve, as recognised in the 2009 Environment Agency Science Report on early warning.

There is a need for systems to better and more clearly highlight the need to take action, rather than overwhelm people with standardised and generic information. Messaging should be:

- Targeted at specific situations and recipients, such as the most exposed to flooding, and those most vulnerable.
- More accurate relating to onset and peak time of the flood and the expected height of the peak.

In order to increase the uptake, messages could be 'pushed' to recipients' cellphones more effectively, as each phone is automatically registered at a local antenna and thus its current location is known, which makes warnings highly specific and localised. They would allow for a swift overview of what is happening and could contain customisable further information, such as links to data, recommendation action and the like. Such examples of this already exist in other areas, for example in the United States. In some cases, better data is still missing to understand especially fast-reacting bodies of water, as demonstrated during Desmond in this part of the Lake District.

Recommendation: More demanding flood scenarios such as repetitive flood events need to be considered when looking at the deployment of emergency and recovery resources

There is a limit to the number of emergency resources locally available, and we recognise these are competing with other resources. However, the floods in December 2015 have demonstrated that while a single event can be managed under current flood emergency planning scenarios, a sudden onset of a second flood, or a larger geographical area being affected by flooding at the same time, will stretch resources significantly.

In order to plan ahead and organise additional support and be prepared for the repetition of the emergency intervention and coping cycle of a flood, more demanding (though not implausibly severe) flood scenarios need to be developed and applied in emergency planning.

Recommendation: Make the transition between coping and recovery smoother

A smoother handover is needed between the emergency phase and the longer-term recovery phase for the affected population. Many people were surprised, even shocked, to realise that certain community centres and services were abruptly stopped as the emergency phase was declared to be over. There should be a clear phase-out/phase-in plan into recovery.

Such phase transitions need to be clearly communicated, ensuring the most vulnerable people, i.e. those most likely in need of these services, are adequately informed in advance.

Recommendation: Learn about and utilise better alternatives to sand bags

Many community members demonstrated an ongoing reliance on sandbags as a method of property-level flood protection, but a frequent and unfit use of sand bags is also seen in industrial and even at community-level contexts.

The reliance on statutory agencies to supply sandbags demonstrates a lack of preparedness despite awareness of flood risk (as some of the individuals reliant on sandbags had flooded previously) as well as demonstrating communities not taking ownership of their residual flood risk.

Today, a range of products such as mobile dams, ‘beaver’ rubber tubes and other temporary measures are available that are much easier to deploy, more cost-effective and more reliable than sandbags and communities, organisations and businesses need to be made aware of their existence and the benefits and limitations of each product.

5.4 Recommendation: Improve and enhance intervention, coping and recovery mechanisms

Recommendation: Improve and enhance intervention, coping and recovery mechanisms

- Address the long-term struggle of socially vulnerable people that are left out.
- Use the opportunity in the recovery process to correct existing flood risk through standardised 'resilient reinstatement' or 'building back better' procedures.
- Create integrated Flood Action Groups with a long-term mandate and recognise them.
- Improve the processes around the limited uptake of the £5,000 resilience grant, provide better independent advice how to sensibly spend it, and integrate it into overall flood resilience measures.

Recommendation: Address the long-term struggle of socially vulnerable people that are left out

Current government investment criteria provides additional support and prioritisation for more socially deprived areas. However if an engineered flood defence scheme cannot be provided that profits such communities and/or areas as a whole, it is vital that vulnerable groups and individuals are similarly identified and prioritised by the EA and local authorities, for example through individual property protection and help with emergency response as well as recovery plans, as needed.

Recommendation: Use the opportunity in the recovery process to correct existing flood risk through standardised 'resilient reinstatement' or 'building back better' procedures

To overcome the trap of just building back and thus suffering repetitive flood losses, a combination of the following will need to be implemented in order to facilitate and incentivise resilience-building during the reinstatement and repair process after a loss:

- A financial incentive is needed to increase the uptake / motivation to reinstate in a more resilient way. This could be a tax incentive, an allowance, a coordinated approach by the insurance industry, or other instruments to alleviate the upfront cost of the investment.
- Standard operating procedures need to be developed and tested how such a resilient reinstatement process will look and function operationally, i.e. who can take a decision on suitable and financially viable opportunities and how can negative consequences ('building golden taps on insurance claims payments') be avoided.
- The experts of the corresponding professions conducting the reinstatement need to be better trained and be more familiar with a suite of applicable products that achieve the resilience reinstatement. This will help overcome the time increase (currently it takes longer to rebuild differently, i.e. better, compared to 'build back') and cost elements (to minimise additional upfront investment to achieve resilience in order to make this seen as financially attractive).

Building resilience through reinstatement or property level protection will lead to the consequent flood damage being reduced over time in places that have flooded, reducing overall societal and economic cost in the long run.

Recommendation: Create integrated Flood Action Groups with a long-term mandate and recognise them

To avoid that interest in the Flood Action Groups wanes and eventually the groups disband because they perceive they have achieved a (short-term) goal, it is important to establish them with a long-term, continued flood awareness and flood risk reduction mandate in mind, rather than a specific (protection) task.

Action groups should be seen and recognised as one piece within an effective flood risk management process. They should be recognised, supported and work alongside flood authorities.

Recommendation: Improve the processes around the limited uptake of the £5,000 resilience grant, provide better independent advice how to sensibly spend it, and integrate it into overall flood resilience measures

People in all areas affected by the Cumbria floods expressed interest in the grant available for property-level protection measures and many agreed that lots of possessions could have been saved or were salvageable. However, many were then discouraged by the application and implementation process.

The application process needs to be simpler. People should understand as to when and how to apply, what to expect, and when. It should also be clear how an independent body such as the NFF can help provide consistent support with applications, and how councils can coordinate the process, obtain quotes from independent flood risk property assessors as well as qualified installation contractors and then how to best make a decision based on their needs.

To optimise future flood resilience, it is important that measures implemented by individuals to protect their property from flooding are fit for purpose. This requires an independent flood risk property survey, as opposed to a product manufacturer or product supplier survey. Communities recovering from flooding are particularly vulnerable to product manufacturers or suppliers capitalising on flood events by opening shops and centres in flood-hit communities, and commonly offering free surveys as part of their overall installation service.

Local, property-specific resilience initiatives also need to be compared to larger scale flood protection measures and should work alongside each other rather than in isolation. Neither spatial nor location-specific protection can work alone, and to optimise the available resources, combined protection within communities is essential. Some communities even mentioned on their own that "they might come together to combine their [individual] flood recovery grant for a larger resilience measure."

Section 6 – Conclusions and outlook

This post-event review of the Cumbria floods is one of many large catastrophic flood events being reviewed using the Zurich Flood Resilience Alliance PERC methodology.

We believe some of the major values that PERC is contributing to the field of forensic disaster investigation are the consistency of its application and the ability for cross-comparison. Only when disaster investigations are not specific one-offs but enable us to generate learning and enable this learning to be scaled beyond an individual report or event coverage will we be truly able to see the big picture emerging. Learning what works and what does not under a variety of contexts and preconditions is a key element of systems analysis, helping us to identify relationships and systematic dependencies that we otherwise would miss.

Section 6 – Conclusions and outlook (continued)

Through the recently published Flood Resilience Portal providing knowledge and solutions at http://floodalliance.net/perc, we are providing a searchable and customisable repository of the learnings from these PERC studies.

In the post-event analyses conducted so far, and this has been a concluding remark in our PERC Nepal Review published in 2015, the role of the government and official organisations versus the part played by autonomous bodies and individuals is a divisive subject. Who is, and who should be responsible for doing what? We have discussed that these answers are changing as risks increase and costs of disasters escalate. In times of very restricted resources available for prevention, we cannot build endlessly high flood walls. Given there are competing interests, we cannot expect one actor (i.e. the Government) to solve the problem alone. There needs to be integrated risk management sharing responsibilities and outcomes, i.e. trying to maximise the overall benefits by taking a particular decision. In the case of Grimma in Germany, flooded in 2002 and then again in 2013, we have seen that relying on the Government alone does not solve the problem. Those people who seek a high level of flood protection for their location may be also the same that disagree on a particular protection structure built along the river near to them. This then often leads to delays and compromises that may defeat the overall purpose of the protection scheme, or lead to the fact that no timely decision is taken at all, leaving the next flood to cause the same rampage as the previous one. It was said in Grimma after 2002, but it cannot be stated often enough: This is something that we must avoid to repeat.

Using comparable methodologies to ask and answer similar questions when a large flood event happens also enables us to identify immediate cross-learnings. We have seen in this PERC Cumbria Review that the uptake of flood resilience grants is slow and unconvincing. Yet, in a PERC South Carolina Flood Review that we are undertaking concurrently, we have identified a best practice of hurricane resilience grants tied to a quality control scheme. Only approved contractors can provide the work and products necessary to improve a home's hurricane resilience, and approval comprises a certification program and continuous education. It also helps remove the difficulties in understanding which products are available and suitable for a given situation, a service which the provider would have to take up as part of the resilience grant application. Vice versa, in that review, grants were limited for the peril of hurricane in coastal areas, with flood not prioritised so far. The learnings of what worked well and what the difficulties were with the UK flood resilience grant scheme could potentially help the corresponding authorities in the US to implement a better flood resilience grant there in less time.

We are proposing that minimum elements are covered when conducting post event reviews to allow for transparent and comparable sharing of lessons learnt. We have also merged our thinking on flood resilience, applying the 5C-4R framework, to our PERC concept in order to highlight which key insights and recommendations belong to which capital and resilience properties. As the Sendai Framework for Disaster Risk Reduction is taking off now, with a key focus on investments in resilience, endeavours in resilience building and growing our knowledge on efficient solutions will only be successful if we can share and compare on a truly global level.

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About the Zurich flood resilience alliance

An increase in severe flooding around the world has focused greater attention on finding practical ways to address flood risk management. In response, Zurich Insurance Group launched a global flood resilience programme in 2013. The programme aims to advance knowledge, develop robust expertise and design strategies that can be implemented to help communities in developed and developing countries strengthen their resilience to flood risk.

To achieve these objectives. Zurich has entered into a multi-year alliance with the International Federation of Red Cross and Red Crescent Societies, the International Institute for Applied Systems Analysis (IIASA), the Wharton Business School's Risk Management and Decision Processes Center (Wharton) and the international development non-governmental organisation Practical Action. The alliance builds on the complementary strengths of these institutions. It brings an interdisciplinary approach to flood research, community-based programmes and risk expertise with the aim of creating a comprehensive framework that will help to promote community flood resilience. It seeks to improve the public dialogue around flood resilience, while measuring the success of our efforts and demonstrating the benefits of pre-event risk reduction, as opposed to post-event disaster relief.

IIASA International Institute for Applied Systems Analysis

Wharton University of Pennsylvania

PRACTICAL ACTION Technology challenging poverty

International Federation of Red Cross and Red Crescent Societies

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