White Paper

A Future Flood Resilient Built Environment

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Introduction

Climate change may have significant implications for the built environment, with impacts likely on buildings, energy, transport, ICT and water infrastructure. Analysis from the UK Climate Change Risk Assessment (CCRA) indicates that the built environment will be affected by extreme weather events. Impacts will arise due to increased temperatures and changing rainfall patterns. Flooding is one of the highest order risks for the built environment and is expected to be more frequent throughout the 21st Century. Flood risk will increase not only due to climate change, but perhaps more importantly increasing urbanisation.

This White Paper has been prepared as a means to engage various stakeholders in a debate on flood resilience in the United Kingdom. The aim of the White Paper is to encourage successful approaches that address existing and future developments in the built environment. Resilient solutions can be developed through research and innovation, but there is a need to address policy and practice in order for such solutions to be implemented.

BRE has been involved in research on flooding of the built environment for over 20 years, from specific research to prepare good practice guidance through to wide ranging programmes of international research under the EC’s Framework programmes.

In the past ten years there has been a growing realisation that flood management has to move from a position where flood defence (e.g. major river barriers and drainage infrastructure) is the only solution to flood risk to one of flood resilience. This shift requires an increase in responsibility for a variety of stakeholders, including property owners. The extent of flood damage to property is increasing as urban areas expand and climate change results in more intense rainfall resulting in more surface water flooding.
The extent of the flood risk to the built environment

The Environment Agency suggests that over 5.2 million homes in England are at risk of flooding from rivers, sea or surface water. This equates to 1 in 6 homes. Annual costs of flood damage are currently at least £1.1 billion (due to all sources) and are expected to rise in coming years as the risk of flooding increases due to climate change. Currently 490,000 properties have a 1 in 75 or greater chance in any given year of flooding (from coastal waters or rivers) but by 2035 this will have increased by more than 350,000. In Scotland, there are currently estimated to be 2.5 million properties.

Across Europe, flooding has been traditionally managed by large scale, engineering solutions whereby entire towns and communities are protected by hard flood defences. Although such defences will still have a role to play in creating resilient places, a rise in ‘intra-urban’ and surface water flooding which often occurs out-with the parameters of structural flood defences, requires a more effective and adaptive flood management approach.

As such, attention has turned to integrating resilience into the built environment. Implementing flood resilience approaches could help the management of flood water and speed up the recovery of people and places.

Flood resilience technologies are a cost effective method of providing flood protection in the UK and there are a lot of properties, both homes and businesses, which are at risk of flooding and would benefit from them. Many available products are low maintenance and have a relatively cheap and simple installation. There are also many products which could equally be used to protect critical infrastructure elements from flooding.
Research and innovation

Research by the University of Dundee for the Scottish Government involved a survey that made a preliminary assessment of possible societal implications of changes to the flood insurance market that may follow the end of the Statement of Principles on the provision of Flood Insurance. The Statement of Principals has both secured the availability of flood insurance to communities at risk of flooding in Scotland, and ensured that the Scottish Government has invested in flood risk management measures during this period. However, the insurance landscape will soon change with the introduction of Flood-Re.

Some of the key findings were as follows:

- Average prices paid for insurance annual premiums in the sample (157 households) were £398 across all areas for those with combined building and contents insurance, £243 for those with separate building insurance alone and £157 for those with contents alone.
- Lower-income groups, below £11,000 per household for the main earner, declared the highest difficulty in meeting hypothetical increased values for future premiums and excesses. All income groups reported that meeting an excess of £10000 on such a claim would be ‘very difficult’ or ‘difficult’, findings that were reinforced by comments in focus groups.
- A particular area of concern expressed by insurance industry representatives is that they have had difficulty to date in accessing information on improvements which may substantially reduce the flood risk for individual properties in a format that would enable those data to be used for commercial purposes.

On the third point BRE, AXA Insurance and Lexis-Nexis are currently undertaking research that addresses the difficulty in accessing information on improvements to buildings to manage flood risk. The Property Flood Resilience Database (PFR-d) project is funded by Innovate UK and will result in the means to inform insurers of relevant measures that have been taken.

The project is innovative as the PFR-d is a ‘missing piece of data’ for insurers that could assist in providing more appropriate insurance pricing in high flood risk areas, or where properties have suffered repeat flooding events. The existing datasets used by the insurance sector are flood risk information in the form of maps and exposure zones used to assess potential flood risk (depth and return period) in the future. What the insurance industry is currently not able to take into account is the investment made by the insured and the government on protecting properties through implementing flood resilience. The project will be undertaken to develop a prototype, involving the gathering and sorting of information on Property Level Protection and resilience of buildings, it will develop the framework for the PFR-d (combining existing datasets with the new PFR-d) and will then pilot the process through a trial area in the UK.
Flood resilient planning and building

In the UK there is an assumption against development taking place in flood risk areas. However, the reality is that development does take place, due to pressure on land and the need to encourage economic activities in specific areas. The principles of planning are concerned with avoidance, but if this cannot be done then resilience and resistance measures should be taken.

Currently building regulations throughout the UK take either limited or no account of flood resilience. Planning may require restrictions to be placed to ensure that resistance or resilience measures are taken, however, these are not always followed through into the construction. In the current climate of ‘deregulation’ it is unlikely that building regulation will address the issue. Therefore, developers will need to produce innovative approaches in order to enable the development of land that may be in marginal areas with residual risks of flooding.

At present there are around 100,000 houses built in England each year and around 25% may be at risk of future flooding (i.e. above a 1 in 1000 year level). Of these 25,000 properties the market for flood resilience should grow from its current low level. The existence of flood defences is often the driver to allow development, but such large scale development of defences is expensive in terms of initial capital and whole life costs. Problems of surface water flooding are increasingly causing problems for existing and new developments, although the focus is still predominantly on river and coastal flood risk.

New developments
The absence of building regulations that adequately address the resilience of new developments to flooding has resulted in there being no effective market for flood resilient property. There is also a ‘disconnect’ between planning requirements that may require resilience measures to be taken, but ultimately there is no way to close the gap. In the absence of building regulation it is necessary for the construction industry to offer innovative design solutions for flood resilient properties.

Existing development
A range of Property Level Protection (PLP) products have developed in the last few years as one way of reducing the impact of flooding and new technologies continue to emerge. Defra and the Environment Agency ran grant schemes installing this equipment in over 2000 homes between 2007 and 2011 and it is now one of the flood risk management options available to scheme designers through Grant-in-Aid. In 2012 Defra and the Association of British insurers (ABI) developed a flood risk report to record the change in the level of risk for a property following the installation of measures.

The most important benefit of property-level protection is its role in limiting the damage, both physical and psychological, caused by flooding. It may also have a role in enabling people to access insurance more easily, possibly even reducing premiums and excess payments. This role is likely to become more important as the support for households at high flood risk provided by Flood Re: the Government’s proposed solution for affordable flood insurance.

Evidence from existing PLP schemes suggests that important barriers to growth in uptake are both:

- the lack of specialist capacity amongst surveyors and
- the lack of independent verification of this capacity to build consumer confidence. Surveyors also have an important role to play in providing assurance to insurers that measures have been properly installed.
Research and innovation

BRE working with other partners has undertaken an innovative design project for a Flood Resilient Property. It uses the principles of resistance and resilience of the property, but it sets out how to deliver such an approach to the mass market house building sector and the low rise non-domestic market. The FRP is directed towards the use of innovative technologies and designs.

As the flood depth increases above 600mm, water is allowed to enter the property at a designed safe flow rate through windows and doors. The controlled inundation of the property avoids the risk of structural collapse through pressure being applied on the walls and involves resilient indoor design and construction.

New innovative materials and products, or existing products used in a new way, are incorporated into the design to ensure this occurs, such as closed-cell cavity wall insulation and automatic shut off valves on water and electric services, linked to flood alarm systems. In addition, measures will be provided so that a family living in a FRP have all emergency provisions at hand, including dedicated storage space for a flood kit and ground floor escape windows for safe evacuation.

The innovative FRP design has the potential to address the insurability of buildings. The target area of risk does not concern the highest level (i.e. greater than 1 in 75), but does address less than 1 in 75 to 1 in 1000, where a substantial number of properties are being built. As the insurance market adapts to Flood Re from 2015, the FRP approach will be important to address new development, especially in the absence of any meaningful standards or regulations in this area.

The British Standards Institution has recently started the process to develop a standard (guide) to improving the flood performance of buildings. The standard should be published within the next 18 months, and will help to direct house-builders and commercial property developers in areas at residual risk of flooding. The initiative has the support of Communities and Local Government (CLG), Defra and industry.

The standard will build on the CLG guidance of 2007 (CLG, 2007) for new developments, and the guidance produced by BRE (with BRE Trust funding) in Digest 523 (IHS, 2012).

Research in the collaborative European SMARTeST (www.floodresilience.eu) and FloodProbe projects (www.floodprobe.eu) examined the use of flood resilience technology. The research demonstrated that the potential of flood resilience technology, including property level protection (PLP) as flood risk solutions for existing property is as yet an untapped source. In trying to increase uptake of PLP and other resilience measures, thereby creating resilient buildings a range of incentives will be needed. The research to develop the Property Flood Resilience Database together with partners in the insurance industry is an example of the innovation needed to allow incentives to be offered to building owners.

Good practice information that the public and building professionals alike can trust and use is also required. A range of SMARTeST research reports have been produced on flood resilience technology in Europe (see the project website). The current research also resulted in the development of the ‘6 steps’ guidance on installation of property level protection, through collaboration between BRE and the University of Manchester, as well as Manchester Metropolitan University. Further the BRE Trust funded a Good Building Guide, Applying Flood Resilience Technologies, GBG84.

Defra funded research is currently being undertaken by JBA and partners to develop the evidence base to support Defra and the Environment Agency’s objectives in driving take-up of PLP and building flood resilience by developing a cohort of competent surveyors. The research is addressing the skills and levels of competencies required for the role of a flood property surveyor. The definition of competence and training needs is essential to provide confidence to the market that the right people are employed in the assessment of measures required and their installation. The project will allow a springboard to certification in this area, which allows a control mechanism for future PLP schemes, and for the use of the PFR-d that is currently under development.
Community flood resilience

Flood effects may range in scale from the local, affecting a neighbourhood or community, to very large, affecting an entire region or river basin and even multiple states or nations. However, not all floods are alike. They may be due to quite different causes and exhibit different behaviour. While some floods develop slowly, sometimes over a period of days, flash floods develop quickly, sometimes in just a few minutes and without any visible signs of rain. They may occur on a regular basis or be very rare. Usually, a distinction is made between floods that are infrequent (with return periods below 20 years), rare floods (with return periods between 20 and 100 years) and very rare floods (return periods exceeding 100 years). Each type of flood requires its own type of responses.

Building the capacity for resilience to flooding needs both formal and informal structures and processes and importantly requires clear linkages and accountability between those structures, so that resources can be freely transferred and exchanged. Community resilience cannot be built in a vacuum (Defra, 2014). There is a range of academic literature that specifically addresses the issue of measurement of community resilience and social vulnerability to natural hazards such as flooding. The measurement, or indication, of community resilience is desirable in helping to develop effective interventions, practices and policies for flood risk management and to build resilient communities.

Research and innovation

Defra has funded a number of Community Resilience Pathfinder projects. The projects will enable and stimulate communities at significant or greater risk of flooding to work with key partners, including local authorities, to develop innovative local solutions that enhance flood risk management and preparedness and improve the community’s financial resilience in relation to flooding.

The scheme is aimed at protecting communities where flooding is a major problem and the projects will be required to demonstrate that they can reduce the levels of flood risk in measurable ways. Thirteen communities have been awarded funding and the measures being developed include property-level protection, flood resilience groups, volunteer flood wardens and community champions, engagement with more vulnerable groups and efforts to increase financial resilience. An evaluation project is being undertaken in order to ensure that lessons can be learned from the Pathfinder scheme, and specifically to report on progress, provide support for the projects’ own evaluations and to report on impact.

BRE undertook research into the compatibility of new development with flood risk areas. The LiFE project addressed the need for new homes, increased risk of flooding and heightened environmental standards simultaneously by integrating three approaches holistically, as follows:

- Living with Water - Adapting to increased flood frequency and severity, likely to happen with climate change.
- Making Space for Water - Working with natural processes to provide space for the river and sea in times of flood and reducing reliance on defences.
- Zero Carbon - Providing all energy needs from renewable resources on site, such as wind, tidal and solar power.

The LiFE project sought to promote good design, where the means of managing flood risk become an asset to the development and the wider community.

The purpose of the guidance produced by the project was to help manage and reduce unacceptable levels of flood risk by raising awareness and aiding delivery of more sustainable development. It was to be used by decision makers, designers and developers before and during the early stages of design. The guidance encouraged developments that are more adaptable to future flood risk changes. The general principles of the approach can be used on all sites. However, the examples cited within the guidance focussed on sites located near rivers and coasts.
Flood resilience: policy statement

The preceding discussion has addressed different areas of flood resilience, with reference being made to a number of research projects and areas of innovation (recent and current) that are intended to improve resilience of the built environment. This section sets out a policy statement on flood resilience, emphasising the key areas that need to be addressed.

Flood resilience
Decision makers, funders and the public should be made aware of the flood resilience options for their property and assets, and understand what types of approaches and technology (PLP/resistance and/or resilience measures) are best suited to their needs.

Innovation in technology
There is a need to encourage industry and the research community to innovate in the use of flood resilience technology. Opportunities for technology development and collaborative research funding should be made available. Research in the areas of performance in tests and practice, durability, maintenance and serviceability are encouraged as well as in technologies that provide minimum intervention, fit and forget solutions or automatic deployment.

Business growth in flood resilience
The sector remains unfulfilled with regards to its potential, therefore measures should be taken by the EU, national governments, insurers and industry to grow the sector in order to realise the benefits. The ‘business case’ indicates many millions of properties and infrastructure assets not only in the UK, but globally. Appropriate assistance of regulatory as well as financial incentives should be used to promote the development of the sector.

Development of flood resilience standards
The development of the BS in flood resilient building design is an initiative that should be encouraged by industry and government. Adoption of flood resilience options for new buildings and designs for retrofitting should be created. The SMARTeST project addressed harmonised standards in Europe for flood resilience technologies, but further emphasis should be put behind such an initiative by governments. Recognised standards that the public can place trust within are essential to creating flood resilient communities.

Flood resilient community, systems and demonstrations
Encouragement should be given to planners, funders and industry to proactively create flood resilient community systems. Good practice demonstration will provide stakeholders with confidence in proposed solutions and will allow a ‘measurement’ of improvements.

Flood resilience tools
A range of tools, which enable flood resilience for new and existing developments are required. Such tools would include those related to risk management and cost-benefit.

Flood resilience guidance
A vast amount of literature and guidance exists in the area of flood resilience, there is a need to bring together ‘best practice’ from what is currently known. Dedication to a maintained publication series that has buy-in from key stakeholders should be encouraged.
BRE offers the following conclusions and recommendations with regards to the flood resilience of the built environment.

**Conclusion 1**
The paradigm has changed, no longer can flooding be defended against fully, instead a flood management approach based on resilience is required. Flooding is the one of the most significant hazards faced in the built environment, affecting property and threatening the life, livelihood and wellbeing of people. Flooding presents a technical challenge in creating a resilient built environment.

**Recommendation 1**
At present policy and practice in flood management do not provide the necessary solutions, either for the present or in the future. It is necessary to invest in a long term programme of research and innovation into the resilience of the built environment. A partnership approach between research organisations, academics, industry and research funders (public and private) is required to develop and deliver the necessary changes to policy and practice.

**Conclusion 2**
There are thousands of new properties built each year in flood risk areas, increasing the overall exposure and vulnerability of the built environment. There are no building regulations and standards that adequately cover the design and construction of resilient buildings, that main the health and welfare as well as retaining the energy efficiency throughout the lifetime. Although research has addressed this issue there is a need to develop a coordinated approach to the design and construction of new buildings in flood risk areas.

**Recommendation 2**
Research and innovation should result in the development of resilient buildings that meet high sustainability standards in other aspects. Current thinking needs to be converted into a series of demonstration and test sites to provide technical solutions that can be adopted by designers and builders.

**Conclusion 3**
The exposure of the current building stock has not been addressed, with current programmes of flood resilience addressing only thousands of properties, as opposed to the millions at risk.

**Recommendation 3**
Research is needed to understand further the full extent of the problem and to set out the opportunities and barriers to flood resilience. Discussions should take place on the need for a compulsory assessment of flood risk for all buildings in the UK. The opportunity for PLP and other flood resilience measures should be determined.

**Conclusion 4**
There are few effective guidance documents, tools, standards and certification schemes related to the resilience of the built environment, therefore the construction industry does not have the capacity and capability to provide effective resilience solutions for new and existing buildings.

**Recommendation 4**
There is a need to resource the development of good practice guidance documents, tools, standards and certification schemes. Standards and certification should include products and people, and include amongst others, new build, retrofitting of existing buildings, competent installers, designers/surveyors and resilience of materials.

**Conclusion 5**
The construction industry is currently ill-prepared to adequately address flood resilience. To draw a parallel it is roughly where the industry was with regards to energy efficiency and sustainability prior to the first oil crisis.

**Recommendation 5**
Education, training and CPD for designers, builders, product manufacturers and property managers is necessary. Dedicated resources should be put towards education in current courses, through to current managers and directors in the industry.

**Conclusion 6**
The paradigms of living with floods and making space for water requires that there needs to be greater acceptance amongst communities and local authorities that water needs to be managed within existing or new developments, rather than seeking to rapidly remove it through run-off and drainage.

**Recommendation 6**
A flood resilient built environment requires research and innovation on the management of water at neighbourhood/community to city level. BRE research in the LiFe project has demonstrated potential sustainable master-planning opportunities, but further research and implementation is required to develop viable (economic, financial, social, technical and environmental) solutions.
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