Risk Nexus

After the storm: how the UK's flood defences performed during the surge following Xaver

Flood resilience review 09.14

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. Since 2013, PERC has analysed various flood events. It has engaged in dialogue with relevant authorities, and is consolidating the knowledge it has gained to make this available to all those interested in progress on flood risk management.

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Cover: The Thames Barrier plays a vital role in protecting the Greater London area from storm surges originating at sea, and river flooding.

About Risk Nexus
Risk Nexus is a series of reports and other communications about risk-related topics from Zurich.

Foreword

Flooding is a risk which concerns all our customers. Whether they are a household, business, community or in the public sector, floods can occur with little warning and have devastating effects. As a leading general insurer in the UK and globally, understanding and mitigating flood risk is a top priority for Zurich.

A key part of our global corporate responsibility strategy is our flood resilience programme, designed to help reduce the impact of flooding on communities worldwide. Closer to home, our dedicated teams provide expert support to customers before, during and after floods. A good example of this is our major incident response unit, which visits affected areas and provides on-the-ground support where it is most needed. This added value is what we believe makes the difference for our customers and sets us apart as an insurer.

The surge after storm Xaver in December 2013 represented a rare weather event across northern Europe, the likes of which had not been seen for over 60 years. Zurich investigated Xaver as part of a wider study into major flood events and this report brings together our efforts at both a global and local level.

The report contains detailed analysis on a number of relevant topics, including UK flood defences and business contingency planning – and makes recommendations for the future. It is no longer enough simply to respond to each incident in isolation; true resilience can only be achieved through an on-going, and over-arching approach to flood risk management. This means working with partners on contingency planning before events, rapid and effective response during them and learning the lessons once the worst is over.

We will use this report to increase our own understanding of the nature of floods and how best to support our customers dealing with their consequences – but we hope the value will not stop there. This report can also be of real benefit to leaders in government, industry and the public sector. We look forward to continuing our work with all of you as we seek to build greater resilience to floods for our customers and our communities.

David W Smith
CEO UKGI and Shared Services
Zurich

Executive summary

This paper was produced as part of Zurich's flood resilience programme – Post Event Review Capability (PERC). It provides an overview and four key insights into the storm surge-induced flooding that took place as a consequence of the large storm known as 'Xaver' in the United Kingdom on December 5 and 6, 2013. While the UK saw an unprecedented series of floods in various parts of the country over the winter of 2013/2014, this report focuses only on the distinct Xaver event. It draws on public information and Zurich's own experience as an insurer in the affected areas.

Worst event since 1953, thousands evacuated, one in six properties at risk

Hurricane Xaver hit northern Europe with severe force and led to the worst storm surge since the disastrous surge following a big storm in January 1953. In the UK more than 10,000 people had to be evacuated and around 1,400 properties were flooded. Power outages affected over 500,000 people across Europe.

One in six properties is at risk from flooding in the UK. Changes in climate mean that in some areas, up to 50 per cent more properties could become at risk from coastal flooding. Luckily, during Xaver there were no fatalities attributed to the surge, and financial losses were far less than they could have been without defences.

Some 800,000 properties protected by defences

Over 2,800 kilometres of defences – some of which were severely tested by Xaver – protected the English coast and 800,000 properties from its surge. The current defence system proved more successful than the performance of the defences in place during the 1953 storm surge, or those used to counter other recent river and surface water flooding. This report provides an overview of the effectiveness of flood defences' cost relative to performance. The value of assets including homes, businesses and municipal structures is increasing. So is population density. We also face numerous future uncertainties, including climate change. Thus, it is important to maintain flood protection investments and to make protection part of an integrated flood risk reduction approach for entire watersheds. Innovative partnerships are required to develop and finance long-term flood resilience solutions.

Every single pound invested in protection saved between £6-10; losses of up to £32 billion avoided

Investing in flood protection and risk reduction measures is costly. But it proves to be a financially valid, successful and important investment when compared with losses where no such protection is in place. On average, £6-10 are saved for every single pound invested, compared with post-event relief and repair. Loss estimates indicate that the defences prevented up to £32 billion of direct financial losses. The Thames Barrier, which cost £1.7 billion in today's values, saves at least £500 million for each 1953-size storm surge event (see also page 12).

> Xaver highlights the importance of sending targeted warnings in advance, and taking the opportunity to rebuild in a way that improves resilience after the event."

Enhance risk awareness and heed flood warnings

Based on the findings from this research, we believe that risk awareness in the UK should be increased. More education and better-targeted warnings are needed to make people aware of the risk. It is vital to know how and when to act if a large event is forecast. The UK's Environment Agency (EA) and Meteorological Office (Met Office) issue storm and flood warnings. In most cases, these warnings have been adequate and timely. Improvements can be made where losses occurred or where losses were aggravated by the fact that people were not aware that a general warning would apply to them. Some had not signed up for targeted warnings and did not take action to protect themselves or their assets.

Early warning and contingency plans can reduce losses by 40 per cent

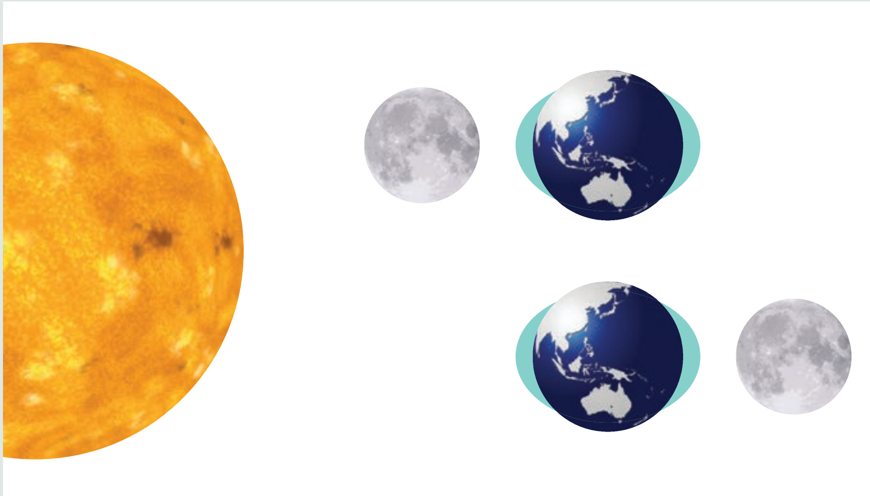
Zurich's post-event investigations show that just a few hours' warning is sufficient to move a significant portion of sensitive assets out of harm's way, as our customers' success stories demonstrate. On average, approximately 40 per cent of losses for building contents can be avoided when early warnings are received. Key to this is being aware of the risk of flooding, preparing a flood contingency and emergency plan, heeding warnings and executing the plan immediately when all indicators show that a flood event is imminent.

Incentivise risk reduction opportunities and build back better

Improvements need to be made to implement 'building-back-better' strategies, and reinstatement should also increase resilience. Overarching policies should provide incentives to encourage risk reduction. Current limitations and restrictions – the time needed to make decisions, getting building permits and investment permissions – make it difficult to increase resilience. The difficulty is exacerbated by a short-term focus on cost rather than looking at the long-term financial benefits, and the goal of reducing risk. Every flood loss offers an opportunity to learn and to increase flood resistance and resilience in the future – the opportunity is lost if properties at risk of flooding are just rebuilt as they were, rather than improving them.

Introduction

During early December 2013, arctic storm Xaver formed in the North Sea and brought hurricane-force wind speeds of 160 kilometres per hour across northern Europe, with a strong pressure gradient between the Atlantic Ocean and central Europe. Tides were also influenced by a new moon, which, like a full moon, due to the alignment with the earth and sun, increases the tidal effect.



Spring tides: at new moon and full moon when the sun, moon and earth are aligned, then tidal forces vary by a higher or lower amount than usual. Modified representation based on an illustration available at: http://www.weltderphysik.de/thema/alltag/springflut/

Preparations were taken and warnings issued for December 5 and 6. During the night, the storm hit the east coast of the UK especially hard: record tides were measured in many locations. Also affected were the coasts of Scandinavia and the northern European continent, for example, around Hamburg in Germany. As the affected countries started to recover, it became clear that the storm surge following Xaver was the worst surge[1] since the devastating great storm of 1953. Thousands of people had to be evacuated. Tens of thousands across the UK and hundreds of thousands throughout Europe were left without power. Tidal waters pushed into estuaries, causing flooding in a number of locations across Europe. In many places, normal public activities came to a standstill.

[1] See glossary at the end of the report.

Even though over 2,000 homes and businesses flooded, as many as 800,000 properties may have been protected by flood defences."

Based on estimates by modellers, insured losses across the event are in the range of EUR 1.4 to 1.9 billion including wind losses and storm surge-related flooding. But they were not as bad as they might have been. Storm surge prevention, which was taken up in many areas following lessons learned in 1953, was effective. For the UK, flood defences have proved their worth. Insured flood losses are expected to reach £100 million. This is low compared with existing loss potentials (Aon Benfield, 2013). Combined wind and flood loss estimates for winter storms Xaver and Dirk are around £400 million (final loss figures were not available at the time of writing).

At the end of January 2014, the Environment Agency estimated that a total of 1,400 homes were flooded; additional information relates to some 1,000 flooded businesses and 3,200 hectares of farmland. Over 10,000 people were evacuated along the east coast. Up to 800,000 properties may have been protected by flood defences along some 2,800 kilometres of UK coastline. Losses from the event for UK insurers and their reinsurers and society would have been much higher had the coastal and tidal river flood defences not been so robust.[2]

This paper begins with a review of a major storm in December 2013, Xaver, and the surge that accompanied it in **Section 1**. A comparison with the major storm that swept across Europe in 1953 follows in **Section 2**, taking into account the effectiveness and cost of the flood defences put in place following that earlier 'great storm.' It includes a discussion of how flood alerts are received, and based on specific cases, looks at how well these warnings were received and acted upon. It also examines the time needed to respond to such warnings.

Section 3 discusses the UK insurance industry agreements, and how these are evolving to better reflect the current realities of the market. **Section 4** summarises the four main learnings from Xaver, and how these might be applied to reduce risks and losses, increase awareness, improve preparations, reduce vulnerability and build resilience should a flood event of the same, or larger magnitude, occur again in the near future. This section includes success stories showing how Zurich assisted its customers during and after the flood, and how claims can be handled efficiently to reduce overall losses and help all of our customers quickly get their lives and businesses back to normal.

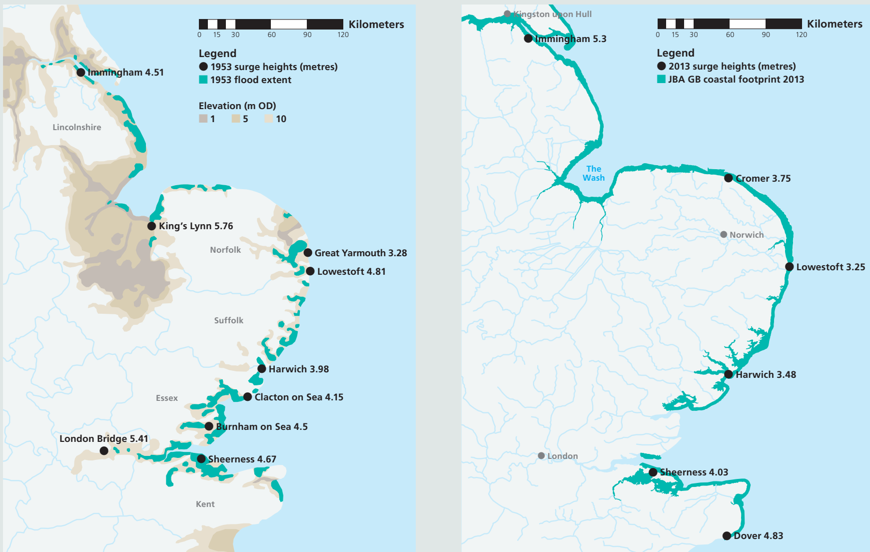
[2] http://www.environment-agency.gov.uk/news/151097.aspx

Section 1
Storm surge following Xaver

> December 2013 was the stormiest month in the UK since 1969."

On December 5 and 6, 2013, storm 'Xaver' (also called Bodil or Sven in Scandinavia by meteorologists in those countries) formed in the arctic across the North Sea. Xaver was followed by further cyclones (large low-pressure systems) with damaging wind speeds and tidal forces, including Dirk.

According to Met Office statistics, December 2013 was the stormiest month in terms of the number of peak wind gusts recorded at over 60 miles per hour since 1969.[3] Large-scale low pressure systems are not unusual in the northern hemisphere in winter, and consequently, this hazard is referred to as a 'European winter storm' or an 'extratropical cyclone' (ETC). An ETC forms in winter due to an interaction of warm subtropical air masses with cold polar air over the Atlantic. The risk modeller AIR estimates that, on average, five ETCs cause significant damage in Europe every year. While ETCs do not reach the peak wind speeds of west Atlantic hurricanes, they occupy a larger area – as much as 2,000 kilometres long by 1,000 kilometres wide – affecting the entire European coast and entering deeply into the European continent before dissipating. AIR simulated that a one-in-100-year type storm could cause insured losses due to wind of up to EUR 15 billion (AIR, 2013a).

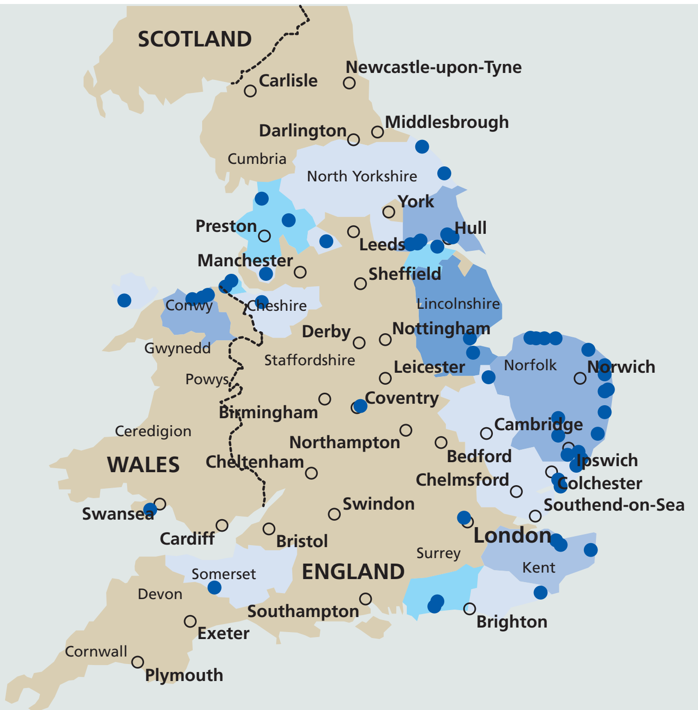


Left: Areas that were flooded in 1953 (shaded green), based on a topographic elevation model (areas shaded brown show elevation in metres above sea level), with surge height information given for specific locations (black dots). Note that this is not a modelled flood footprint. With kind permission of RMS (2003). **Right:** Flood footprint with areas flooded in 2013. Note surge height in metres for selected locations. With kind permission of JBA risk management (2014).

[3] http://www.metoffice.gov.uk/climate/uk/interesting/2013-decwind

> Kingston-upon-Hull recorded a new all-high tidal level of 5.8 metres. Dover measured the highest tide level since 1905 at 4.7 metres."

Xaver brought hurricane-force winds of around 160 kilometres per hour across northern Europe, with a strong pressure gradient between the Atlantic Ocean and central Europe. This constellation, together with a new moon, led to very strong tidal forces. Preparations were taken and warnings issued for December 5 and 6. The Thames Barrier was raised several times during the tidal cycles in order to protect the Greater London area. On the night of December 5, the storm hit the East coast of the UK especially hard. In Kingston-upon-Hull ('Hull'), a new record tide level of 5.8 metres was measured (Environment Agency; Hull Daily Mail, December 7, 2013) and caused some significant flooding, especially in built-up areas affected by the Humber estuary. Hull's tidal barrier at the mouth of the Hull River, which was built in 1980, protected key areas of the historic city centre from severe flooding. In Dover, the highest tide level since 1905 was measured at 4.7 metres. It is estimated that the storm surge protection system saved between 19,000 (EA) and 25,000 (Hull City Council) houses from flood waters there. Besides the impact on homeowners, the businesses affected in Hull included those of Zurich corporate customers and landmark buildings such as the ice arena. Flooding, measured at 5.8-meter surge level, could have been much worse had the barrier been overtopped, which would occur at a tidal level of 6.3 metres.



Claims 'hot spot' areas for floods during the Xaver storm surge period, where each blue dot represents a significant claim. Reproduced with kind permission of Crawford & Company Global Technical Services (2014).

Section 2
Key insights and success stories

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Without protection in place, a repetition of the 1953 storm surge would cost hundreds of billions of pounds.”

2.1 Comparing Xaver’s surge with the surge of the 1953 storm

The 1953 storm surge that developed on January 29 of that year near Iceland intensified as it moved towards the North Sea. With a very low minimum pressure of 966 mbar (RMS, 2003), winds and waves battered the European coasts on the night of January 31, 1953.

The 1953 storm surge hit just two days after the full moon. The forces of the storm combined with those of the spring tides and the gravitational pull of the moon and sun being in alignment intensified the surge. More than 2,000 people lost their lives; 307 of those were killed in eastern England alone, making it the worst disaster from a natural event in UK’s recent history (ABI Coastal Flooding 2006; BBC September 24, 2009). The tides in the UK were also the highest recorded for at least the past 250 years (RMS, 2003). In total, an area of approximately 600 square kilometres was flooded in the UK.

What would happen today or tomorrow?

A catastrophic scenario simulation called ‘Flood Ex’ was carried out in 2009 to test emergency services. This scenario simulated conditions based on those of the 1953 catastrophe. It was assumed that approximately 2.5 to 5 million people would be affected by such an event, and that tens of thousands would need to be rescued from flood waters. Losses could go into the hundreds of billions of pounds. This dwarfs the loss estimate of the 1953 event, which stands at roughly £1 billion of economic losses in 2003 values, with very low flood insurance penetration at that time.

If flooding of the same magnitude occurred today, accounting for the increase in population, wider wealth distribution and greater insurance penetration, it is estimated that an insured loss would amount to £5.5 billion (RMS, 2003). Given that flood defences have improved significantly since then, simulations by RMS (2003) using its probabilistic UK storm surge model indicate that today, insured losses would amount to £470 million, which corresponds to a one-in-40-year return period (2.5 per cent annual probability). However, these events are likely to become more frequent due to the effects of degradation of old flood defences, which need to be maintained and upgraded; the effects of increasing population and settlement pressure; the higher monetary value of assets; and the effects of climate change and rising sea levels. For some areas, it is estimated that a one-in-750 to one-in-1,000-year (0.133 per cent to 0.1 per cent annual probability) event such as the original 1953 storm surge could become a one-in-20-year event (or five per cent annual probability) by the end of this century. This leaves much to be done in terms of flood protection and land zoning if a one-in-100 year (1 per cent annual probability) protection goal remains the objective.

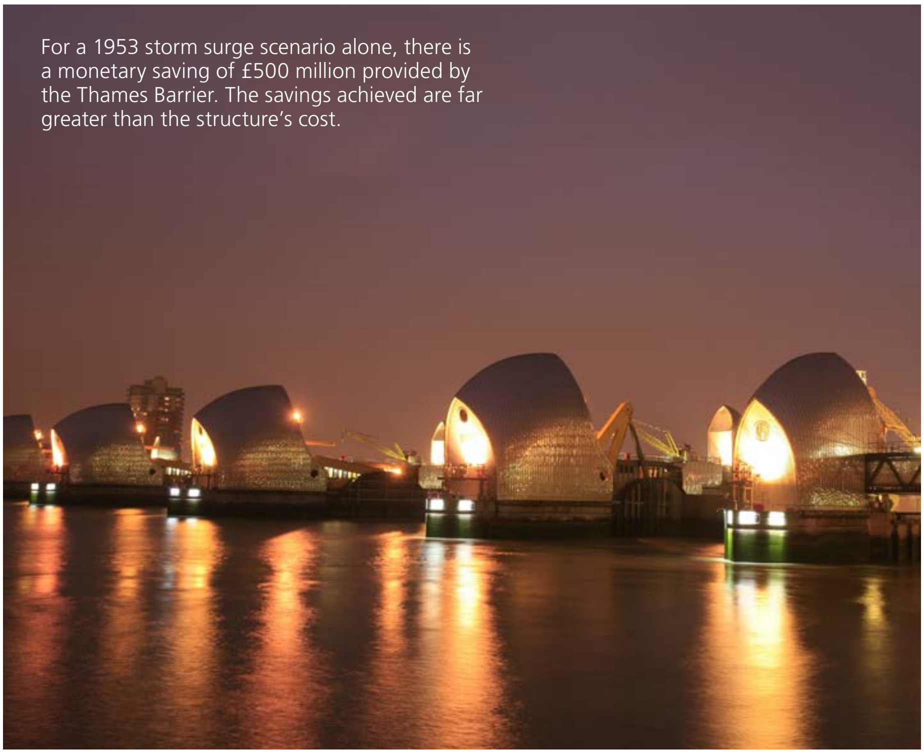
One in six properties is already at some risk from flooding. This amounts to 2.4 million properties at risk from river or coastal flooding (Environment Agency, 2013). In the eastern UK, this amounts to 270,000 properties exposed to coastal floods alone. This number is expected to increase by about 48 per cent using modelling under climate change projections (ABI, 2006).

UK protection systems prevented losses of approximately £32 billion."

2.2 The benefits and costs of flood defences in the 2013 event

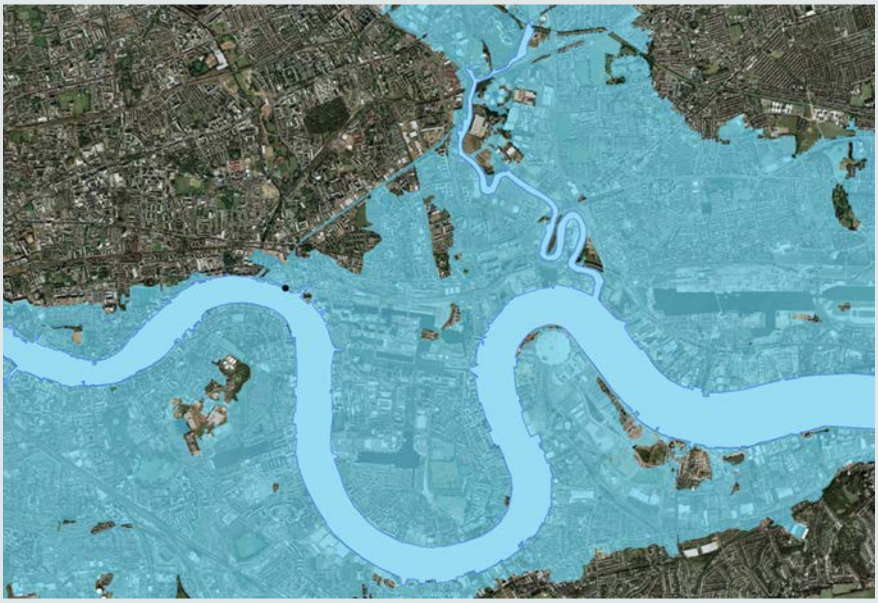
Xaver's storm surge in December 2013 clearly demonstrated that most of the coastal flood defences have performed well and saved economic and insured losses in the billions of pounds, compared with the cost of an event of the magnitude of the 1953 surge, with no flood defences or inadequate defences in place.

Besides the financial aspects, society, health and safety benefit in ways harder to quantify that include both non-monetary and monetary advantages. In 1953, a government review found that some 1,200 defences were breached and 24,000 houses and 200 industrial facilities damaged or destroyed (RMS, 2003). The Environment Agency estimated that for the Xaver event, approximately 800,000 homes were protected by modern defence systems across the UK.[4] Based on the simple average loss assumption of £40,000 per property once flooded to a certain threshold water level (the basis of some UK estimates), this would equate to avoided losses of £32 billion. The Environment Agency has a forward-looking procedure to assess the economic viability of flood defence projects. Various studies find benefit-to-cost ratios in similar ranges, for example of £8 saved for each pound spent (EA, 2009), or of £7 to one pound (ABI, 2006) and in projects specific to the 2007 floods of £6 to one pound (EA, 2007). In this report, we use a retrospective approach to roughly assess costs and benefits for some of the most important existing defences, based on the events that have taken place since they were installed.



For a 1953 storm surge scenario alone, there is a monetary saving of £500 million provided by the Thames Barrier. The savings achieved are far greater than the structure's cost.

[4] http://www.environment-agency.gov.uk/news/151097.aspx?page=2&month=12&year=2013&sector=Flood



This simulation by the Environment Agency shows areas that would be flooded if the Thames Barrier was not there to protect London from tidal forces in the Thames.[5]

a. Thames Barrier

As a result of the surge from Xaver, the Thames Barrier saw the highest tide level since it was built in 1983. It protects the Greater London area of approximately 125 square kilometres from storm surge flooding (London Strategic Flood Framework, 2012). London is no stranger to such flooding. In 1928, for example, large areas of London along the river were inundated. In 2013, at Southend on the Thames Estuary, the tide level was recorded at 4.1 metres, 0.06 metres higher than its previous record in 2007.[6] The Thames Barrier was originally designed to hold back water levels that would result from a one-in-1,000 year (0.1 per cent) storm surge flood, factoring in a rise in the sea level and climate change assumptions. Given the observed trends, the barrier is reportedly still overachieving its one-in-1,000 year protection goal. RMS (2003) has estimated that the monetary benefit of insured direct property losses could be avoided that otherwise would have amounted to £500 million if the same extent of flooding as 1953 were to occur again (not including business interruption or other loss-related costs). This compares with the £535 million final building cost (original value, approx. £1.4 billion in 2007 value), plus £8 million in annual maintenance and operating costs, and £10 million in capital upgrade costs. Since its construction, the barrier has been raised over 120 times. In order to compare cumulative economic benefit of avoided losses for the Thames Barrier against its total cost, we assume a typical extreme value distribution of flood events and look at the differential between losses with, and without the barrier. The savings achieved by the Thames Barrier are far greater than the structure's cost. Zurich estimates the total benefits of the Thames Barrier to be in the order of one magnitude larger than the £500 million saved during a major disaster like the 1953 storm. That would equate to about £5 billion saved, compared with the structure's cost of £1.7 billion in today's values.

[5] http://www.huffingtonpost.co.uk/2013/12/09/london-flooding-thames-barrier-picture_n_4411086.html

[6] http://www.environment-agency.gov.uk/news/151138.aspx?month=12&year=2013&sector=Flood

> In the Hull area, 90 per cent of developed land is below sea level at high tide."

b. Hull Barrier and Humber estuary

The Environment Agency was satisfied with the performance of most coastal defence systems in the area. It estimates that the flood defences of the Hull river and the Humber estuary combined have saved up to 100,000 homes from flooding and that losses avoided just in the city of Hull thanks to the barrier amount to £250 million (Hull Daily Mail, December 7, 2013), after an estimated £250 million had already been saved in a 2005 tidal surge (BBC, January 2005[7]). This proves the value of the barrier. By way of comparison, before the barrier was built, a significant flood in Hull in 1969 inundated the entire city centre. Yet losses in the 2013 event were reported from some 100 properties in Hull, and the flood protection structures were themselves damaged. Damage sustained this time mostly came from the Humber estuary rather than the river Hull, a success for the defence system. In total, the Hull barrier has prevented flooding from over 33 severe tidal events since its introduction.

However, while the flood protection systems have done a great job this time, it must be accepted that return periods of similar flood events are likely to become more frequent due to climate change and human action, and flood risk is increasing as more assets are located in areas subject to flooding. In Hull alone, some 90 per cent of built-up land is located below high-tide level (Hull Daily Mail).

The Environment Agency's Humber Flood Risk Management Strategy document (2008) acknowledged that improvements to Humber estuary defences are necessary and that an area with a population of some 400,000 is currently not protected up to a one-in-100 year standard. There is a desire to achieve this level of protection in most areas but it may not be economically viable everywhere – as a result, flood defences may fail and flood risk may increase for the affected population. For protection requirements that are not economically feasible in the short and long term, one must think the unthinkable: To give up the land and relocate, as has been done in some other countries.

c. Warrington water scheme

In 2012, the Environment Agency began working on the River Mersey to protect over 2,000 homes from flood risk. This £23-million plan for roughly five-kilometre-long flood walls, plus 2.2 kilometres of embankments, will provide one-in-100 year protection from both tidal and river flooding. This is a great example of a partnership approach, where both the Environment Agency and the local council worked together to make sufficient funds available. Recent flood events in 1990, 1998, 2000, 2002 and 2006 have underscored the importance of this project. So have investigations by the Agency, including a national ranking of at-risk areas using a benefit-to-cost analysis that is carried out for each project before it goes ahead. This demonstrates that this is a priority project that will benefit large numbers of people at risk of flooding (Environment Agency, 2011).

During Xaver, with the first phase of the project just completed, the defence strategy was operated for the first time and protected 1,500 properties from the storm surge travelling along the Mersey[8] – a £60-million estimated benefit for this event alone using the average property-loss approach.

[7] http://news.bbc.co.uk/2/hi/uk_news/england/humber/4170671.stm

[8] http://www.environment-agency.gov.uk/news/151097.aspx

One day prior to the event, 41 severe flood warnings were issued. Not all at risk received or heeded the warnings. Significant property and business interruption losses were sustained."

2.3 Targeting flood warnings to ensure they are received

While flood defences performed well in many areas, significant losses still occurred. Visits to affected areas by Zurich flood experts have highlighted again (compare with the initial report and the retrospective on the central European floods in 2013[9]) that structural flood protection systems cannot provide 100 per cent safety and can still be breached or overtopped under many different conditions.

If these conditions are present, it is vital that people at risk protect themselves and their property. An adequate and precise flood warning from experts and/or authorities followed by the execution of a well-founded flood emergency and contingency plan can significantly help to avoid or reduce direct flood-related losses (property damage) and indirect losses (for example, downtime and business losses).

The Met Office and Environment Agency operate a wide system of alerts and warnings for meteorological and hydrological hazards. These are available free of charge through a telephone-based Floodline service and via these offices' websites, which are available to subscribers or can be accessed via social media. These public channels target the general population, helping to alert people to flood warnings to encourage them to take appropriate action.

On December 4, 2013, one day before Xaver struck, the Environment Agency urged communities to "prepare for the worst east coast tidal surge in 30 years"[10] and provided forecasts of the counties most likely to be affected, including those in the northeast (Norfolk) and along the east coast (Lincolnshire, Suffolk, Essex), as well as some areas in north Wales.

Property damage and business interruption at a beach management centre along the east coast.

[9] http://knowledge.zurich.com/flood-resilience/

[10] http://www.environment-agency.gov.uk/news/151055.aspx?page=2&month=12&year=2013&sector=Flood

The Scarborough beach front sustained significant storm surge damage, including damage to a sea wall.

By 4:30 p.m. on December 5, the Environment Agency had issued 41 'severe' flood warnings ('severe' is the highest category) that provided information about the hazard and its intensity, clearly stating that "sea levels could be higher than those during the devastating floods of 1953" (Environment Agency Website, December 5, 2013[11]). The insurance industry was aware of these developments and began issuing its own warnings starting at noon on December 5, stating that water levels along some parts of the coast were predicted to exceed 1953 tidal-surge levels. However, people we interviewed after the event indicated that, in many cases during the storm surge caused by Xaver, they were unaware of an imminent flood event, or even that they were at risk. While they may have understood that a general warning was broadcast and that Xaver was underway, they did not perceive that it could affect them, and thus did not take any action that could have saved them from losses, or did so only when it was too late because the water had already entered their homes or business premises.

In contrast to those who were not aware of the risk they faced, Zurich visited customers in the Lowestoft area, which also sustained significant flooding that topped installed flood defences, but where a detailed flood emergency and contingency plan was in place. Site management teams reacted efficiently and in a timely fashion and executed the plan, evacuating mobile or demountable high-value equipment, raising lifts and began preparing for power outages. They were able to reduce losses, maintain key operations on site and speed up recovery.

Clearly, there were a large number of adequate warnings: 160,000 warnings were sent to homes and businesses before the peak of Xaver's storm surge hit.

The transition between strong storm wind warnings and warnings about storm surge flooding, however, was gradual; warnings were not well-targeted because forecasts could not be precise; warnings were not communicated well to some people who were most at risk. One reason might have been intense media coverage of Nelson Mandela's death, which dominated headlines as Xaver was approaching. There was also a focus on sending the message, but not enough emphasis on, and insight into, how these messages were received by people at risk of floods. In many cases, messages were not sufficiently well targeted, and those affected, though perhaps aware of the general warning, did not know that they were at risk. A more targeted approach to warnings would be more effective. After the 2007 floods, the Environment Agency said in a review that 41 per cent of those who could receive flood warnings by phone or text messages had subscribed to the service – a total of 276,000 recipients, up from 79,000 in January 2006, when the flood line alert system was put in place. The system focused on automatically registering people at risk, requiring them to 'opt out' rather than 'opt in.' This clearly increased the number of people reached. Even so, only 20 per cent of those affected in flooded areas had signed up. Further problems are created as landlines are given up in favour of mobile phones. Mobile phones have to be registered separately, making it harder to reach people at risk, as the mobile phone numbers are not tied to a location.

Interviews and past experience show there is a fine line between too much and too little warning. People will not listen if too many exaggerated warnings are issued and then nothing happens. The public tends to confuse false alarms with justified warnings when all conditions to issue the warnings are present, but where, thanks to luck, losses turn out to be low or non-existent. It follows that clear warnings must be issued, and that recipients need to be educated on how to interpret and heed them based on personal needs or business requirements.

[11] http://www.environment-agency.gov.uk/news/151075.aspx?page=2&month=12&year=2013&sector=Flood

An adequate response to flood warnings received four hours or more in advance can reduce damage by 43 per cent."

2.4 Hours matter – how to get assets out of harm's way

The following examples demonstrate the importance of flood risk awareness, adequate preparedness and the need to take appropriate actions in line with an established flood emergency plan.

a. Flood loss at a retail park

A large retail park on the Humber estuary was flooded. Site management teams and tenants were unaware of the flood risk and reportedly did not receive any specific warning that their properties were at risk of being flooded by the storm surge. Water began to enter the premises late in the evening of December 5. Security personnel noticed this and warned all tenants. Quite soon thereafter, people were asked to leave the premises and were evacuated to higher ground. Only a small number of authorised personnel were allowed to stay on site to try to rescue what they could in the short time available until water began to top door sills and flow into storage areas and retail spaces. None of the businesses we interviewed had established a flood emergency plan or agreed on a procedure, and just tried to save what they could in the short time available – for example, electronic equipment and furniture that was easy to move. While this was easier for businesses with smaller retail spaces or where items were either portable or not susceptible to being damaged by a few inches of water, others did not fare so well. Clothing stock proved especially susceptible to damage and hard to move, and much of it was destroyed. Based on the layout of the shops and the value of stock, it is clear that agreed contingency plans and an adequate warning time of a few hours would have been enough to reduce these losses significantly. This experience also shows that emergency procedures need to be peril-specific and tailored to the needs of individual businesses. Here, a high proportion of the contents lost could have been saved by a few hours' warning and appropriate action to move stock. Studies show that flood warnings help to substantially reduce losses of contents and equipment. On average, a flood warning received at least four hours before the event can reduce damage to contents and equipment by 43 per cent, if warnings are heeded and the response to them is adequate. (Flood Hazard Research Centre, 2005).

Flooded building being dried out at a location in Lowestoft.

Contingency planning resulted in a return that was 10 times greater than the cost that otherwise might have been incurred due to flood losses."

b. Successful flood loss reduction
In contrast to the preceding example, Orwell Housing Association (an assisted living organisation based in Lowestoft) had identified the risk of flooding a few years earlier when water from a high tide suddenly flooded its premises. A few years ago, Zurich recommended a flood risk assessment and preparation of a flood emergency and contingency plan. This led to the installation of mobile flood defences to a one-in-75 year return period protection level, and the creation of a detailed flood emergency plan. While the 0.8 metre-high flood defences – the highest possible level for these manual barriers – were overtopped during Xaver's storm surge, they helped to reduce losses and delayed the flooding that occurred.

The emergency plan allowed elderly residents to remain upstairs on the premises, freeing them from the inconvenience of having to adjust to a new environment in a temporary shelter. The management team was also able to move critical equipment and installations out of harm's way, significantly reducing property losses and avoiding a complicated reinstatement process and the 'downtime' this would have otherwise entailed.

An estimate shows that for the approximately £7,500 invested in the flood defences and costs for the appraisal and the emergency plan, around £100,000 was saved by avoiding contents losses and operational downtime, a more than 10:1 return on flood protection investment, not counting the social benefits. Because procedures had been agreed and backup equipment was available, a minimum level of operations could be maintained on the upper floors of the premises, even though the ground floor was completely flooded.

The value of this approach is evident when comparing it with a similar operation in the neighbourhood where the absence of preventive measures and the lack of an emergency plan led to the complete interruption of the business and a costlier clean-up and reinstatement period. Zurich's claims, underwriting and risk engineering teams have assisted this customer not only with reinstatement, but also to analyse potential flood risk reduction measures to further protect the affected premises in the future. The customer has adopted a proactive risk management and flood risk reduction approach that should be used more often in the future. On site, this needs to be

Visible water line from the surge event at a location with protection installed, including mobile defence at the door.

> Every loss is an opportunity for building back better, but there are challenges to overcome to make it happen under resource and time constraints following an incident."

seen in the context of the individual town's or district council's flood defence strategies. In this particular town, a plan was commissioned earlier in 2013 (unfortunately too late to reduce losses from Xaver's storm surge), which foresees investing £32 million in a tidal flood defence gate (Waveney District Flood Protection, 2013). Overall, what is needed is an integrated and cost-effective flood risk reduction strategy rather than a 'flood wall behind another flood wall.'

c. Building back better

The goals of Zurich's flood risk assessment and risk management strategies include increasing flood resilience, reducing potential losses and, ultimately, reducing overall economic flood risk. One approach seeks to identify weak spots or areas with high flood risk after a loss has occurred and uses these opportunities during reinstatement to make improvements at low or no additional cost. These might include fittings and installations that are easily damaged by flood waters, including wooden floorboards at ground floor level or electrical systems, things we identified during several visits. Installing more flood-resistant material will be beneficial, especially in areas of high flood hazard and where frequent flooding is expected. However, legal restrictions or construction constraints sometimes make it hard to build back better. It is easier to build back to the same condition (and therefore to the same level of flood vulnerability) as before – a problem which has already been identified by Zurich in our research on the 2013 central European flood event[12]. Building requirements and flood protection must therefore be aligned so that flood risk reduction can be achieved wherever needed.

How difficult the building-back-better approach during reinstatement can be is illustrated by the case of a loss at a visitor centre operation in a nature reserve, which has several buildings spread across a large estate. The site evolved over many decades, and while clearly located on a flood plain (and furthermore, on the 'water-side' of a flood gate and natural protection of a dune), flood resilience or protection measures were not put in place. When the loss was analysed after the flood on the night of December 5, which closed down the visitor centre and its related operations, it became apparent that significant damage up to £100,000 had been incurred. To reduce flood risk and to avoid similar losses in future – which was assessed as very likely – major changes are necessary that include those to the location, layout and/or fittings. However, this would also require extensive planning and a decision-making process that would conflict with the desire to rebuild the facility to its former state as quickly as possible to reduce business interruption and restore normal operations. Innovative solutions are needed to avoid recurring large flood losses that will make it easier to underwrite flood risk and eliminate the significant problem of flood clean-up and business interruption. Incorporating flood resilience into new projects is always a far easier and less-costly task than upgrading existing properties or making them more flood resilient. Working more closely together and partnering with customers, tenants and local authorities will make it easier to find innovative solutions, while taking into account flood protection schemes in the area.

[12] http://www.zurich.com/en/corporate-responsibility/flood-resilience

Section 3
Insurance industry agreements

In the UK, an agreement known as the 'Statement of Principles' existed between the government and the insurance industry between 2001 and 2013. This was essentially a 'quid pro quo' agreement stipulating that the industry would continue to make flood cover widely available while the UK government maintained its spending on flood defences.

Over time, it became apparent to all stakeholders that the Statement of Principles was no longer fit for purpose and was leading to market distortions and cross-subsidies. As a result, a not-for-profit flood fund known as Flood Re – which aims to ensure that flood insurance remains affordable and available to homeowners at high flood risk – has recently been agreed by the UK government and the insurance industry. Enabling legislation will take effect from 2015, and the Statement of Principles has been extended until this time. Flood Re is designed as a solution for the next 25 years, whereby insurers will put into the fund those high flood-risk homes they feel unable to insure themselves and the portion of the household premium that covers the flood risk is capped. The cap will be based on council tax bands and all home insurance policyholders will be subject to a levy. On average, this works out to be £10.50 a year on all home insurance policies. Until Flood Re becomes operational, there still are a number of implementation measures to be taken. These are being addressed by Flood Re's chief executive and its programme board.

It is hoped that over the period that Flood Re operates there will be a managed transition to flood insurance for households that reflects risk and, as a result, by 2040, there will again be a free market for household flood insurance.

As part of the legislation, the UK government has also passed back-up plans in the form of the 'Flood Insurance Obligation' (FIO), which would require insurers to take on their share of high-flood-risk households. The FIO would apply in the event of Flood Re not being fully implemented. A UK-wide register of high-risk properties (about 500,000) would be created and each insurer, based on market share, would be allocated a quota of high-risk properties.

Based on the assumption that there is enough market capacity for non-residential properties, these were not included in the Flood Reinsurance scheme.

Post-flood clean-up operation underway in Scarborough, where seafront arcades and cafés were flooded along the South Bay. The tide level here was estimated at approximately 6 metres above normal tide levels.

Section 4
Recommendations

Based on the insights gained by researching Xaver's storm surge and the information outlined in the preceding chapters, Zurich recommends the following for locations in the UK, but also applicable in the rest of the world:

a. Consider storm surge defences

Storm surge defences worked well in the 2013 flood event compared with previous high-intensity storms with surge. Not only have they protected up to 800,000 homes from flooding, but evidence shows that this protection is also cost-effective with a high 'return.' Countless non-quantifiable or non-monetary benefits also need to be assessed in an overall cost-benefit assessment.

b. Implement pre-event risk mitigation

Pre-event risk reduction and protection strategies are important and should be given priority over post-event relief and repairs. Yet they cannot work in isolation and all stakeholders need to communicate and coordinate to identify the most viable integrated flood risk reduction solutions, of which structural flood defence plans are a part. There is thus an urgent need for various stakeholders to participate more fully in pre-event mitigation and measures to enhance flood resilience.

c. Increase cooperation between public and private entities

Experience shows that insurers, government authorities and other key stakeholders need to work more closely to encourage risk reduction in both the public and private sectors (Amendola et al., 2013). Zurich is willing to help with planning and flood protection options for any new buildings and greenfield sites to increase resilience. Should losses occur, lessons from the event can and must be learned and opportunities identified to make new buildings more resilient and reduce potential losses.

Attention also needs to be paid to locating property development away from flood risk whenever possible and preventing inappropriate new development in areas at risk of flooding. This can be helped by ensuring that flood risk is taken into account at all stages in the spatial planning process. Evidence indicates that development in floodplains is continuing, regardless of Environment Agency advice. Environment Agency figures suggest that during 2012/2013, 549 residential units were constructed under plans that ignored Environment Agency advice. Continued building on floodplains is an issue that has existed for many years and that the accumulation of such properties has steadily increased. There are efforts to 'manage down' the number of properties in this category, but more can be done to make Environment Agency advice binding on development applications.

d. Raise risk awareness

Another important aspect of risk reduction is to foster risk awareness and encourage risk-averse behaviour. A well-established risk management approach to reduce flood risk needs to include those at risk, be they private homeowners or commercial businesses. All parties need to understand the flood hazards and potential consequences that apply to them, in particular to what extent they are at risk and how they can do their share to protect themselves. Whether protection is structural, local around their property, or larger scale, it must be integrated into an overall flood protection scheme.

The Thames Barrier's gates can open and close to protect the Greater London area from storm surges of the North Sea.

e. Draw up flood contingency plans

Protection should also include flood emergency and contingency plans outlining what can be protected temporarily as a flood event is unfolding; this must include sufficient lead warning time to execute the plan. Depending on the type of operations, one to two hours' advance notice may be enough to protect or evacuate key assets in a retail or private home environment, while larger operations need more time and preparation. When an event is imminent, warnings need to be sent in the right sequence and to the right audience so they are understood and can be heeded. Examples from Zurich clients and others have shown that well-prepared and well-executed emergency and contingency plans have great merit. However, they require practice and should be updated as situations change.

The next large flood event will certainly come, but we cannot predict when and where it will occur. The next one could be caused by intense precipitation leading to widespread surface flooding. Zurich has provided information on how to prepare for such a scenario. Please visit http://insider.zurich.co.uk/market-expertise/growing-threat-surface-water-flooding-urban-areas/ to understand how built-up areas can be made more resilient to surface water flooding.

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About Zurich

Zurich is a leading multi-line insurer that serves its customers in global and local markets. With more than 55,000 employees, it provides a wide range of general insurance and life insurance products and services. Zurich's customers include individuals, small businesses, and mid-sized and large companies, including multinational corporations, in more than 170 countries. The Group is headquartered in Zurich, Switzerland, where it was founded in 1872.

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 organization 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 www.iiasa.ac.at

Wharton University of Pennsylvania

PRACTICAL ACTION Technology challenging poverty

International Federation of Red Cross and Red Crescent Societies

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Glossary

Cyclone: a moving, rotating low-pressure system influenced by predominantly westerly winds, often associated with large-scale rain systems across Europe.

Depression: an area of low atmospheric pressure that often is associated with precipitation.

Flood defence: flood defence infrastructure such as flood walls and embankments intended to protect an area against flooding to a specified standard of protection.

Flood map: in the UK, for example, a map, produced by the Environment Agency showing the probability and extent of flooding in all areas of England and Wales, assuming there are no flood defences. Only covers river and sea flooding.

Flood hazard: Before a risk is created, a hazard needs to be present that poses a threat to life, property or negatively affects the outcome of a plan or project. In order to create flood risk, a (natural) flood hazard from rivers, the sea or from surface runoff after intense storms needs to be present first. Flood hazard can be expressed in probability of occurrence at a given location and can be modeled or mapped using flood maps.

Floodplain: an area of land that borders a watercourse, an estuary or the sea, over which water flows in time of flood, or would flow, but for the presence of flood defences.

Flood risk: the combination of the flood hazard that is present in an area of vulnerable assets or people that can be harmed. Typically (flood) risk is the multiplication of the (flood) probability times the severity of the adverse consequences.

Hurricane: winds that reach a speed of more than 118 km/h (force 12 on Beaufort's scale) are sometimes called hurricanes, irrespective of the origin. This should not to be confused with the term 'hurricanes' for tropical cyclones occurring in the eastern Pacific or the western Atlantic during the summer months.

Millibar: unit or measure of pressure (mbar) used in meteorology to describe the current atmospheric air pressure; the equivalent expression in SI-units of Hectopascal (hPa) can be used interchangeably.

Probability of occurrence: the term '100-year flood' refers to a statistical event that has a one per cent chance of happening in any given year. It is important to recognize that this does not mean that the event will only happen once in a 100-year period. Rather, a 100-year flood event can happen more than once in any given year, and it can occur once a year over several years in a row. To better understand the flood probability, a 'one per cent annual chance' is better-suited to expressing the situation. Thus, a 100-year flood is simply a statistical benchmark, and should only be used as such. The water level of a 100-year event may be referred to as HW100 and the corresponding floodwater flow as HQ100.

Return period: the long-term average period between events of a given magnitude, which have the same annual exceedance probability of occurring (the chance of a flood occurring can also be expressed as a probability) e.g., a one-in-100 years return period.

Storm: an event during which a disturbance in the atmosphere is present, often associated with stronger winds and intense rainfall. To assess the impact a period of rainfall is having on the flow of water bodies, the term storm event is often used to separate intervals of dry periods from periods during which precipitation is measured and quantified.

Storm surge: defined as the difference in water level between the predicted normal tide and the actual height of the tide, resulting from low atmospheric pressure and the wind forcing the water towards shore.

Thames Barrier at night.

Disclaimer and cautionary statement

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