THE GENEVA ASSOCIATION

INSURANCE FOR A BETTER WORLD

Building Flood Resilience in a Changing Climate

Insights from the United States, England and Germany

June 2020

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The Geneva Association

The Geneva Association was created in 1973 and is the only global association of insurance companies; our members are insurance and reinsurance Chief Executive Officers (CEOs). Based on rigorous research conducted in collaboration with our members, academic institutions and multilateral organisations, our mission is to identify and investigate key trends that are likely to shape or impact the insurance industry in the future, highlighting what is at stake for the industry; develop recommendations for the industry and for policymakers; provide a platform to our members, policymakers, academics, multilateral and non-governmental organisations to discuss these trends and recommendations; reach out to global opinion leaders and influential organisations to highlight the positive contributions of insurance to better understanding risks and to building resilient and prosperous economies and societies, and thus a more sustainable world.

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Foreword

The parallels between the COVID-19 pandemic and climate risks are clear: they cost far more to react to than to prepare for, and the most severe costs are borne by the most vulnerable.

Floods are the costliest weather-related events globally. Major flooding events are common, and the increasing frequency and severity of weather-related events linked to climate change will likely increase the direct and indirect economic impacts of floods. Countries must be prepared.

The Geneva Association has carried out broad and deep investigations into the flood risk management (FRM) systems of a number of countries, beginning with the studies on the United States, England and Germany summarised in this report.

Our findings are at least partly encouraging. Governments recognise that floods are a critical issue. They are taking action to protect those most exposed to flood risk and assisting populations that may not be able to protect themselves. They are increasingly prioritising building resilience to floods.

But there is still more to do. Our studies reveal disproportionate investment in response over sustainable recovery and measures to effectively reduce the risk. Governments need to be better coordinated, particularly across federal/national and local levels, and at the same time embrace and define shared responsibilities with other stakeholders.

Insurance is a big part of the solution, but access and take-up are not where they should be. People and businesses need more and better information – improved flood risk maps as well as historical information on property they intend to purchase – and governments need to ensure it is provided.

With these in-depth country studies, The Geneva Association aims to spread awareness of gaps in flood protection, as well as successful approaches to FRM already in place, and in doing so, shape the way forward for public and private actors to strengthen society's resilience to this urgent and growing risk.

Jad Ariss
Managing Director

1. Executive summary

As the world responds to the COVID-19 crisis and governments prepare their economic stimulus plans, the potential compounding effects of weather-related extremes such as floods, tropical cyclones and wildfires could significantly challenge a country's emergency management capacities and slow down socio-economic recovery. This study is focused on building resilience to floods in a changing climate. It points to the need for a paradigm shift from reacting to crises towards a risk-based, anticipatory, holistic and all-of-society approach to managing the potential impacts of catastrophes.

Flooding is one of the most important physical climate risks in many countries, affecting households, communities, businesses and governments on a regular basis.

There are several kinds of floods:

- Fluvial floods (river floods)
- Pluvial floods (flash floods and surface water)
- Coastal floods (storm surge and coastal tidal flooding)

Each kind differs in terms of occurrence, potential damage and management measures.

Building resilience has become a priority for many countries around the world in recent years, due to the major socio-economic effects of flooding, including threats to human lives and livelihoods as well as direct and indirect economic impacts.

The costs associated with floods are growing in many places due to the combined impacts of

- Increasing concentrations of people and assets in areas of high flood risk linked to land use, urbanisation and development practices; and
- The increasing frequency and severity of weather-related events linked to climate change (e.g. changing storm and precipitation patterns and rising sea levels) (Intergovernmental Panel on Climate Change (IPCC) 2018).

Over the last decade, underpinned by three international framework agreements,[1] some governments have started to adopt a more proactive approach to disaster risk management (including for floods), engaging a variety of stakeholders (The Geneva Association 2016, 2017). Despite some progress, a number of hurdles remain related to policy and regulatory constraints, institutional and sectoral silos and capacities,

1 The United Nations Hyogo Framework for Action (2005–2015), Sendai Framework for Disaster Reduction (2015–2030) and The Paris Agreement, which have been adopted by over 190 member states.

conflicting and/or competing priorities and insufficient coordination within and across layers of government and with other key stakeholders, such as the private sector and non-governmental organisations (NGOs).

As part of its commitment to strengthening socio-economic resilience to extreme events and climate change, The Geneva Association has undertaken this study to take a deeper look at the evolution of flood risk management (FRM), particularly in light of the changing risk landscape. Specifically:

- This study offers a comprehensive review of FRM in three high-income countries with mature insurance markets: the U.S., England (a constituent country of the U.K., as defined by the Commonwealth) and Germany;
- Special attention is given to mapping the evolution of governance, institutional frameworks and the interplay of different components of FRM, including risk assessment, risk communication and awareness, risk reduction, risk prevention, risk financing, risk transfer (e.g. insurance and alternative risk transfer) and reconstruction measures;
- Trends and patterns are explored and key findings and recommendations for stakeholders aiming to improve FRM systems in any country are provided;
- The study did not set out to draw comparisons among the three countries, or to identify and promote best practices. In fact, a best practice in one country may not be so in another, as it cannot be isolated from the governance, institutional and cultural environments in which it was originally developed.

The methodology, framework for FRM analysis, overall findings from the three case studies and overall recommendations are provided in this overview report. Case studies for the U.S., England and Germany are available in The Geneva Association (2020a), (2020b) and (2020c), respectively.

Key trends and findings

- **Flood risk:** The rising socio-economic impacts of floods have become a national concern in all three countries particularly in the immediate aftermath of flood events. The three countries are impacted by fluvial floods (river floods), pluvial floods (flash floods and surface water) and coastal floods (storm surge). Recurrent, high-impact flooding has led to growing political, public and insurance industry concern, particularly around the need for action to reform FRM systems and strengthen flood resilience. The generation and management of flood risks are impacted by actions taken by different stakeholders.
- **Institutional roles and responsibilities:** There is growing evidence that approaches to FRM are slowly evolving from efforts to control water to building resilience to floods. Countries are increasingly taking into consideration a risk-based and more collaborative approach to FRM. Protection of the most vulnerable citizens, particularly those residing in very high-risk areas, remains a critical issue for governments.

  FRM entails a range of policies, interventions and activities, delivered by a variety of stakeholders, with different incentives and priorities. This creates complementarities, duplication and sometimes gaps in efforts related to FRM.

  Importantly, the evolution of FRM in the three countries differs significantly, driven by a variety of country-specific factors. For example, types and impacts of flood risks; each country's governance structure; overall strategy, policies, regulatory frameworks, institutional arrangements, coordination and dynamics within and across layers of government to address FRM; institutional and cultural legacies associated with FRM; the extent and nature of engagement between the public and private sectors (namely, insurance, banking, development and real estate); availability and accessibility of decision-relevant risk information for all members of society; overall risk awareness, risk perception and ownership

across society; societal perceptions of and the governmental approach to post-disaster aid versus protection through insurance; and considerations for climate change, which are deeply connected to the politics in the country.

- **Risk information and communication:** In the last decade, the need for flood-risk assessment and communicating about risks has gained significant momentum although with different levels of success and impact on government, business, community and homeowner decisions. The level of risk awareness and utilisation of risk information in decision-making varies greatly among stakeholders and in many cases, risk information is not decision-relevant, for example, for local governments and homeowners.

- **Alerts and early warnings:** The three case studies confirm significant progress toward the implementation of early warning systems to enhance emergency preparedness and response operations to save lives and expedite post-disaster assessments and claims payouts.

- **Risk reduction and risk prevention:** The need for ex-ante investments in risk reduction and risk prevention measures by governments, businesses, communities and homeowners is slowly coming into focus. However, when it comes to implementation, there are different priorities, approaches and levels of coordination among agencies and levels of the government. Implementing these measures is critical to driving affordability and to the sustainability of insurance programmes.

  There appear to be perverse incentives in all the countries, particularly with the government agencies responsible for land-use planning and building-code decisions that may limit actions to reduce and prevent risks.

- **Risk financing:** Risk financing and contingency planning for protection of government budgets is gaining some attention, particularly at the national level. However, none of the three countries have established a pre-disaster budget or contingency planning process, with funds appropriated by the government after the event.

- **Risk transfer (insurance and alternative-risk transfer):** The value proposition of the insurance industry is evident. Beyond facilitating financial protection for recovery, the insurance sector in some countries provides flood-risk analytics and modelling, assists in flood-risk communication and awareness campaigns, and incentivising risk-reduction and risk-prevention measures. However, the sustainability and affordability of insurance products remains deeply reliant on the ex-ante efforts of governments to invest in risk-reduction and risk-prevention measures. Furthermore, limited take-up of insurance is linked to low levels of flood-risk awareness and understanding of the benefits of insurance, underestimating the potential impacts of severe floods and reliance on other support mechanisms such as post-disaster government handouts.

  Collaboration between the government and insurance industry can help boost accessibility, affordability and the sustainability of insurance as a key contributor to enhancing flood resilience. At the heart of this issue is the need for the government and insurance industry to be more deeply committed to working together towards promoting and incentivising risk reduction and risk prevention and to achieving mutually agreed definitions of their respective roles.

- **Reconstruction:** There is growing recognition of the need to build back smarter after an event in order to strengthen resilience to future events in medium- and high-risk regions, with clear guidelines on how to build. However, meaningful action from those involved in the recovery and reconstruction process has been limited. Climate change considerations are not systematically factored in and politically motivated decisions, such as to not build back at all or relocate from high-risk regions, are sometimes taken.

- **Multi-stakeholder engagement:** Cross-sectoral and multi-stakeholder collaboration and initiatives prove to be highly beneficial, although efforts are needed to develop and sustain such mechanisms beyond awareness raising and towards real action.

- **Overall FRM Approach:** Despite all the developments, FRM systems remain, in general, reactive to floods, pointing to the need for a more anticipatory, cohesive and systems-based approach to addressing this growing risk. Furthermore, the development of FRM systems need to be an integral part of economic development and climate adaptation strategies at all levels of the government. Finally, a major shortcoming in all countries is that they do not rigorously and systematically monitor the impacts and benefits of investments in risk awareness and communication, risk reduction and risk-prevention measures in order to make ongoing improvements to the system.

Recommendations

FRM is a multi-faceted challenge that requires coordinated action from a wide range of stakeholders, with clearly defined roles and responsibilities, effective collaborations and incentives. A shift towards a more anticipatory FRM

approach requires a change in behaviour not only from those tasked with managing risks, but also those at risk or involved in creating risks. The shift towards a more anticipatory focus is important, particularly in the face of climate change and other emerging risks. As the world grapples with managing the health and socio-economic impacts of the COVID-19 crisis, the need for a paradigm shift towards a risk-based, anticipatory, holistic and all-of-society approach to managing risks of disasters cannot be stressed enough.

Recommendation 1 **Governments** should develop a *clear national strategy for FRM*, with an anticipatory, cohesive and systems-based approach to building flood resilience. This should be an integral part of economic-development and climate change-adaptation plans. They should establish effective mechanisms to leverage the strengths, expertise and innovative solutions of key stakeholders, particularly the private sector.

Governments should (i) move from reactive to proactive approaches that consider the changing risk landscape caused by climate change and other socio-economic drivers; (ii) consider that FRM entails highly interdependent measures, including risk assessment and risk communication, risk reduction and prevention, risk financing, risk transfer and building back better after an event; (iii) re-evaluate and reform their post disaster aid programmes to incentivise flood-risk reduction and prevention measures, while considering measures for the most vulnerable populations; (iv) make it mandatory to disclose previous flood events to potential property buyers (e.g. through flood disclosure laws) in the early stages of their decision-making; and (v) establish mechanisms for monitoring and improving the FRM system and its components over time.

Recommendation 2 The **insurance industry** should further *step up their proactive engagement with governments and their customers*, as risk advisers, risk management experts, risk underwriters and investors, to support the implementation of FRM systems to strengthen resilience to floods. Specifically, national insurance associations should work with their members to find effective mechanisms for industry-level engagement and collaboration with government authorities to identify and develop practical and sustainable solutions to enhancing socio-economic resilience to floods.

This could include sharing risk information, providing risk management advice, engaging in risk awareness campaigns, sharing practical guidelines on risk reduction and preventive measures for homeowners, businesses and governments and offering innovative insurance products that incentivise risk reduction.

Furthermore, insurance companies, in light of developments related to the Task Force on Climate-related Financial Disclosures (TCFD), should evaluate the impacts of changing flood risks on both sides of their balance sheet (liabilities and investments) and also offer risk modelling and risk management advice to their commercial clients for implementing TCFD recommendations.

Recommendation 3 **Businesses and households** should proactively seek flood-risk information; *understand and take responsibility for managing their flood risk*; and make risk-informed decisions.

Recommendation 4 **International organisations, academic institutions, professional and executive education programmes** could utilise this study in their awareness-raising campaigns and educational programmes targeted at government officials, policy makers, businesses and the general public, *promoting the need for a risk-based, anticipatory, cohesive and systems-based approach*, which takes climate change into consideration for building flood resilience.

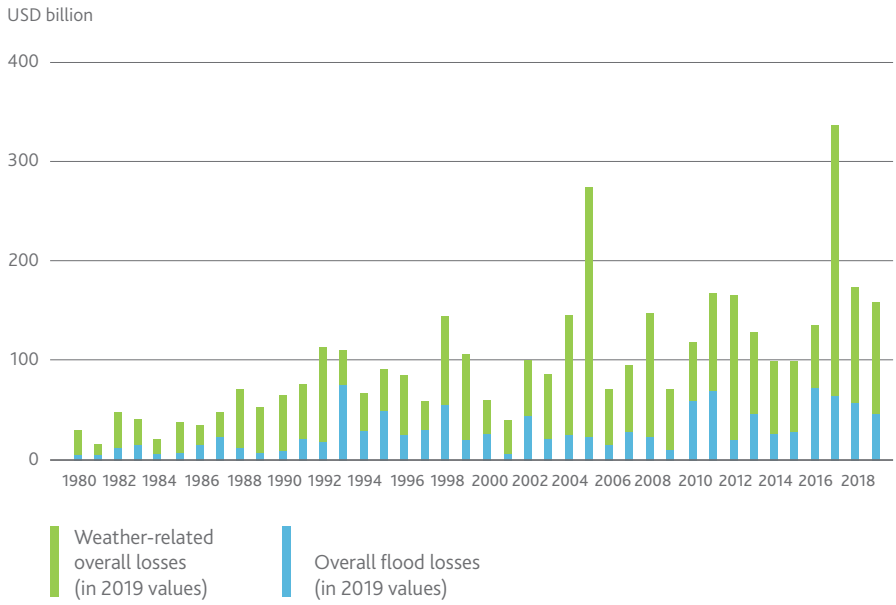
Recommendation 5 **Government officials, the insurance industry and other stakeholders** responsible for FRM in the U.S., England and Germany should come together in their respective countries, *review and discuss the gaps, challenges and weaknesses* identified in our review and find effective ways to work together to enhance their FRM system towards a more cohesive, systems-based and forward-looking approach. The national insurance associations in each country could play a key role in convening these stakeholders.

2. Introduction

2.1. Flood risk: A major physical climate risk and a growing global concern

Economic losses from weather-related extremes have been rising significantly over the last three and a half decades (Figure 1). From 1980 to 2019, Munich Re's NatCatSERVICE has identified around 19,000 disaster events caused by natural hazards, of which over 91% were weather-related (meteorological, hydrological, and climatological) events (Munich Re 2019). These events accounted for 89% of the total of 1,740,000 lives lost, 86% of the USD 5,000 billion in total economic losses, and 90% of total insured losses of USD 1,400 billion, both inflation-adjusted. Of the total weather-related events globally, floods accounted for the largest share at 41% of the 17,300 events, 28% of 890,000 lives lost, 27% of USD 4,000 billion economic losses and 10% of USD 1,300 billion insured losses.

Figure 1: Overall economic losses associated with weather-related and flood-related disasters 1980–2019

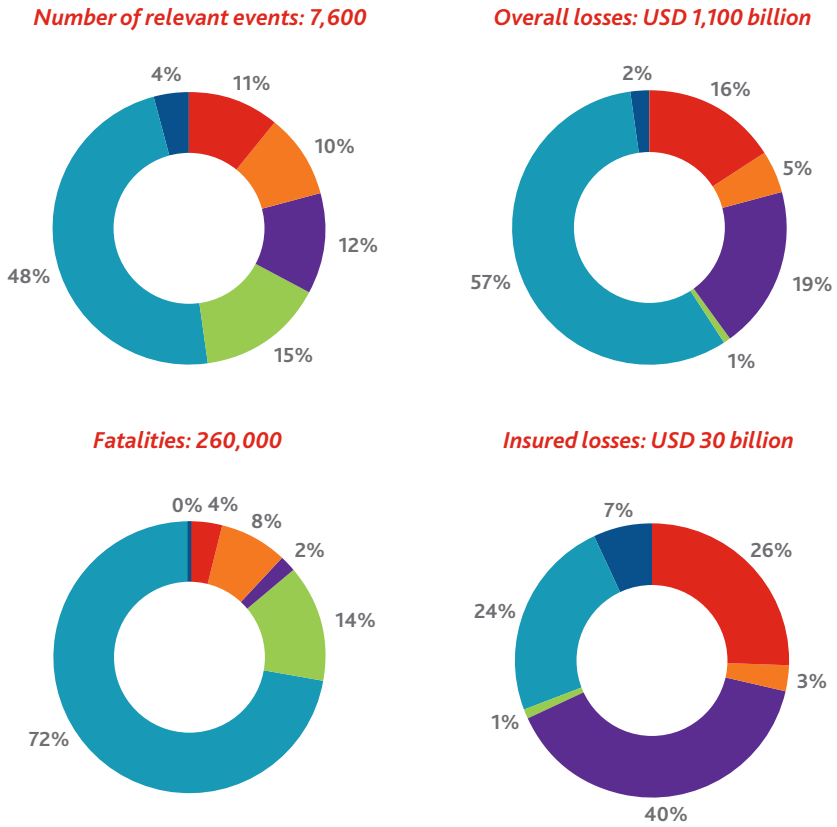


Inflation adjusted according to the country-specific consumer price index and consideration of exchange rate fluctuations between local currencies and USD.

Source: NatCatSERVICE Munich Re, as of February 2020

Asia accounted for the greatest share of events, fatalities and economic losses, whereas Europe accounted for highest insured losses, followed by North America and Asia (Figure 2).[2]

Figure 2: Number and impacts of flood events by region: 1980–2019



Source: NatCatSERVICE Munich Re, as of January 2020

Accounted events have caused at least one fatality and/or produced normalised losses ≥ USD 100k, 300k, 1 million or 3 million (depending on the assigned World Bank income group of the affected country).

Inflation adjusted via the country-specific consumer price index and considering exchange-rate fluctuations between local currency and USD.

2 For more information about flood risk in Asia see The Geneva Association 2015.

Table 1 lists examples of how physical climate risks can cause direct and indirect losses for governments, businesses, homeowners and individuals.

For many countries, flooding is a growing national concern impacting residents/households, communities, businesses and governments (Box 1). The impacts of flood events are further exacerbated by a number of factors related to changing exposures, vulnerabilities and hazard characteristics. These include (i) an increasing concentration of people and assets in areas of high flood risk, linked to land use, urbanisation and development; and (ii) the increasing frequency and severity of weather-related events linked to climate change (e.g. sea level rise and changing storm and precipitation patterns) (Intergovernmental Panel on Climate Change (IPCC) 2018).

Table 1: Examples of the direct and indirect impacts of physical climate risks

Governments	• Emergency relief and response • Relocation of affected and at-risk populations • Reconstruction costs • Rehabilitation and recovery • Contingent liabilities for state-owned enterprises and enterprises critical to economic recovery • Decreased tax revenues from business interruption • Opportunity cost of diverting funds to reconstruction and recovery efforts • Increased expenditure for social recovery programs • Increased borrowing costs and potential negative impacts on the sovereign credit rating • Migration of populations due to loss of livelihoods
Businesses	• Disruptions to employees • Loss of assets and inventory • Reconstruction of assets • Disruption to critical infrastructure needed for operations • Disruption to supply chains • Spillover effects from business interruptions • Increased borrowing costs
Homeowners and individuals	• Loss or damage to homes, personal property and other assets • Loss, damage or disruption to essential infrastructure, e.g. schools, hospitals, water and sewage management, transportation, energy • Risks to food security and water safety • Forced relocations and additional living expenses • Mental health and other health-related issues with potentially long-lasting impacts

In the face of escalating losses globally, over the last several years, the need to building resilience to floods has increasingly become a priority for governments, communities, businesses and households. Growing flood risks not only pose threats to human lives and livelihoods, but also cause substantial economic impacts.[3]

3 We have used the U.S. National Academy of Science's definition of 'resilience': 'the ability to prepare, plan for, prevent, absorb, recover from and more successfully adapt to adverse extreme events such as floods'.

Box 1: Types of floods

A flood is an overflow of a large amount of water beyond its normal limits, especially over what is normally dry land. There are several different kinds of flood, and each varies in terms of how it occurs, how it is forecast, the damage it causes, and the type of protection that may be needed. There are three common types of floods:

1) Fluvial floods (river floods): A fluvial, or river flood, occurs when the water level in a river, lake, or stream rises and overflows onto the surrounding banks, shores, and neighbouring land. The water level rise could be due to excessive rain or snowmelt.

The damage from a river flood can be widespread as the overflow affects smaller rivers downstream, which can cause dams and dikes to break and swamp nearby areas. The severity of a river flood is to a substantial extent determined by the duration and intensity (volume over a period of time) of rainfall in the catchment area of the river. Other factors include soil water saturation due to previous rainfall, snow pack and associated snowmelt, the terrain surrounding the river system and river water management. In flatter areas, floodwater tends to rise more slowly and be shallower, and water can remain for days. In hilly or mountainous areas, floods can occur within minutes after a heavy rain, drain quickly, and cause damage due to debris flow.

2) Pluvial floods: A pluvial flood occurs when an extreme rainfall event creates a flood independent of an overflowing water body. A common misconception about flood is that you must be located near a body of water to be at risk. Yet pluvial flooding can happen in any location, urban or rural, even in areas with no water bodies in the vicinity. There are two common types of pluvial flooding:

- ***Surface water floods*** occur when an urban drainage system is overwhelmed and water flows out into streets and nearby structures. It occurs gradually, which provides people time to move to safe locations, and the level of water is usually shallow (rarely more than one metre deep). It creates no immediate threat to lives but may cause significant economic damage.
- ***Flash floods*** are characterised by an intense, high velocity torrent of water triggered by torrential rain falling within a short amount of time within the vicinity or on nearby elevated terrain. They can also occur via sudden release of water from an upstream levee or a dam. Flash floods are very dangerous and destructive not only because of the force of the water, but also the hurtling debris that is often swept up in the flow.

3) Coastal flood (storm surge): Coastal flooding is the inundation of land areas along the coast by seawater. Common causes of coastal flooding are high tides, intense windstorm events pushing water inland (storm surge) and tsunamis.

Storm surge is created when high winds from windstorm force water onshore – this is the leading cause of coastal flooding and often the greatest threat associated with a windstorm. The effects increase depending on the tide – windstorms that occur during high tide result in devastating storm surge floods. In this type of flood, water overwhelms low-lying land and often causes devastating loss of life and property.

The severity of a coastal flood is determined by several other factors, including the strength, size, speed, and direction of the windstorm. The onshore and offshore topography also plays an important role. To determine the probability and magnitude of a storm surge, coastal flood models consider this information in addition to data from historical storms that have affected the area.

Source: Zurich Insurance https://www.zurich.com/en/knowledge/topics/flood-and-water-damage/three-common-types-of-flood

2.2. Global trends in disaster and climate-risk management

In context of this study, several developments and trends are worth highlighting:

1. Building on the international movement inspired by UN framework agreements, there is a growing recognition of the importance of disaster risk assessment, risk communication, risk awareness and utilising risk information to underpin decisions by the general public, business and all levels of government (UNDRR GAR 2011, 2013, 2015, 2017, 2019; The Geneva Association 2018a).

2. In response to the COVID-19 crisis, governments are making efforts to stimulate their contracted economies. Weather-related extremes, such as floods, tropical cyclones and wildfires, could significantly challenge a country's emergency management capacities and slow down the socio-economic recovery. The importance of a paradigm shift from reacting to crises towards a risk-based, anticipatory, holistic and all-of-society approach to managing potential impacts of such events has been stressed.

3. The rising impacts of weather-related events, such as floods, are also gaining the attention of the financial sector. This is driven by the concern that climate change could be a systemic risk to global financial stability, creating the need to enable long-term financing for a well-planned transition to a resilient low-carbon economy.[4] The Financial Stability Board's (FSB's) Task Force on Climate-related Financial Disclosures (TCFD) provided general and sector-specific guidelines for publicly traded companies to assess and disclose their climate-related risks in their annual reports (TCFD 2017). Increased financial disclosure of climate risks is important for investors, rating agencies and governments (TCFD, 2018, 2019);[5] floods are considered a physical climate risk in the context of TCFD (Box 2).

   The abilities of companies to manage physical climate risks not only depend on their own internal risk management measures, but also on the actions of governments and other stakeholders to improve risk management practices, such as for floods, in the jurisdictions where these companies operate and own assets.

Box 2: Floods in the context of physical climate risk as defined by the TCFD

According to the TCFD, physical climate risk includes economic risks that could arise from direct impacts, such as the destruction of property and critical infrastructure, and indirect impacts, such as business interruption, affecting the labour force and the interconnectivity of supply chains, due to

- Increasing severity and frequency of extreme weather events such as tropical cyclones, forest fires and floods (acute risks)
- Long-term shifts in climate patterns such as changes in precipitation patterns linked to reduced water supplies and sustained high temperatures that may cause rising sea level and heatwaves (chronic risks).

Source: Task Force for Climate-related Financial Disclosures 2017

   International rating agencies, such as Moody's Financial Services and the S&P Global Services, recently started considering climate and disaster risk and related risk management practices in their sovereign, municipal and corporate credit ratings (New York Times 2019; Bloomberg 2019).

4. Significant progress has been made over the past 15 years to protect lives by implementing early-warning systems and emergency preparedness measures (UNDRR GAR 2015, World Meteorological Organization 2014; Golnaraghi 2012).

5. The need for ex-ante investments in risk-reduction and risk-prevention measures is starting to receive attention from finance ministers and economic development agencies. A number of studies have found that ex-ante investments could save four to 10 dollars in post-disaster spending (Global Commission on Adaptation 2019).

4 The former Chairman of the FSB, Mark Carney, has emphasised the need for companies to assess, manage and disclose their climate risks (physical and transition) (Carney 2015). He launched the TCFD, which is chaired by Michael Bloomberg.

5 At the time of publication, it is not compulsory to respond to the TCFD. However, a number of jurisdictions, such as the U.K., France and the Netherlands, are moving towards making it and related scenario analysis and stress testing mandatory.

6. Increasingly, there is recognition that risk reduction and risk prevention is not only the responsibility of governments, but also businesses, communities, homeowners and individuals (World Bank 2018a-b; OECD 2017; The Geneva Association 2019, 2017, 2016).

7. Risk financing and contingency planning to protect government budgets is gaining more attention, particularly at the national level, in the context of overall financial resilience and funding capacity to respond and recover from disasters in a timely manner (OECD 2017; World Bank 2014, 2015; World Bank-SECO 2017).

8. With rising impacts of natural hazards in all countries, there is more attention on the role and value proposition of the insurance industry in driving disaster resilience (OECD 2016, 2015a-b; The Geneva Association 2018b-c and 2019a-b; InsuResilience 2019; Kousky 2019). This is also supported by emerging evidence that countries with widespread market-based insurance coverage tend to recover faster from the financial impacts of extreme events; and that it is the uninsured part of losses that drives macroeconomic costs (Von Peter et al. 2012). This has not only generated more interest in traditional insurance products, but also spurred innovations in alternative risk transfer solutions. Furthermore, increasingly governments are realising the value proposition of working closer with the insurance industry in areas such as catastrophe (CAT) risk modelling, climate adaptation and disaster prevention research (The Geneva Association 2018a). However, there is evidence of an insurance protection gap[6] in all countries, which needs to be addressed (The Geneva Association 2017, 2017, 2018c, 2019b).

9. There is growing recognition of the need to build back smarter after an event. However, there is little evidence of any meaningful action being undertaken at a large scale during repair and recovery (New York Times 2019; Surminski 2018).

10. Governments are increasingly recognising that their post-disaster financial assistance, in the face of rising disaster impacts, are proving to be ineffective and insufficient and they dis-incentivise local governments, businesses and residents from proactively reducing their risks (The Geneva Association 2016 and 2018b).

11. The macroeconomic impacts of weather-related extremes, such as floods, point to the need to integrate these measures into national development planning, budgeting and climate adaptation strategies, particularly in relation to building resilience within national financial systems (e.g. mortgage and banking sector and insurance companies) (World Bank 2018).

2.3. About this study

This study is designed to explore challenges and opportunities for strengthening societal resilience to floods. We define 'resilience' as 'the ability to prepare, plan for, prevent, absorb, recover from and more successfully adapt to adverse extreme events such as floods'.[7]

As part of its commitment to strengthening socio-economic resilience to extreme events and climate change, The Geneva Association has undertaken this study to take a deeper look at the evolution of FRM, particularly in light of the changing risk landscape.

i. This study offers a holistic, multi-stakeholder, forward-looking review of FRM in three high-income countries with mature insurance markets: the U.S., England and Germany;

ii. Special attention is given to mapping the evolution of governance, institutional frameworks and the interplay of different components of FRM, including risk assessment, risk communication and awareness, risk reduction, risk prevention, risk financing, risk transfer (e.g. insurance and alternative risk transfer) and reconstruction measures;

6 According to the Swiss Re Institute, 'protection gap' is defined as 'the share of uninsured losses in total economic losses' (e.g. around 70% for global natural catastrophes). Swiss Re estimates that global natural catastrophe losses in 2018 resulting from three named perils totaled USD 292 billion. Meanwhile, there was a protection gap of USD 222 billion, or 76%, in premium equivalent terms. The largest protection gaps relate to earthquakes (USD 135 billion), floods (USD 50 billion) and storms (USD 37 billion). For more information, see https://riskandinsurance.com/global-protection-gap-reached-trillions-but-might-be-good-news/

7 As defined by the U.S. National Academy of Science.

iii. The report explores trends and patterns and provides key findings and recommendations for stakeholders aiming to improve FRM systems in any country;

iv. The study did not set out to draw comparisons among the three countries or to identify and promote best practices. In fact, a best practice in one country may not be so in another, as it cannot be isolated from the governance, institutional and cultural environments in which it was originally developed.

This study has involved interviews, consultations and roundtable discussions with key stakeholders from governments, the insurance industry and various organisations active in FRM systems in each country.

Case studies for the U.S., England and Germany are documented in The Geneva Association 2020a, 2020b and 2020c, respectively, and their key findings are provided in this report as follows:

- Section 3 summarises the framework applied to reviewing and documenting FRM in country cases studies;
- Section 4 provides an overview of country-specific trends and findings;
- Section 5 highlights overall trends and key findings;
- Section 6 offers recommendations for the way ahead.

3. An enhanced framework for flood risk management

This study offers a holistic, multi-stakeholder and forward-looking framework to analyse FRM systems in the three countries. The components of this framework are described in this section and illustrated in Figure 3.

1. **Risk governance, including clarity on roles and responsibilities of key stakeholders to manage flood risks.**

   With governments at the centre of this issue, developing the national FRM strategy as an integral part of economic development and climate adaptation strategies, budgeting and planning is fundamental. Key considerations include clarity of roles, aligning priorities, policies and regulations, and coordinating within and across levels of the government. Protecting the most vulnerable populations – those living in the highest risk zones – is a major consideration for governments.

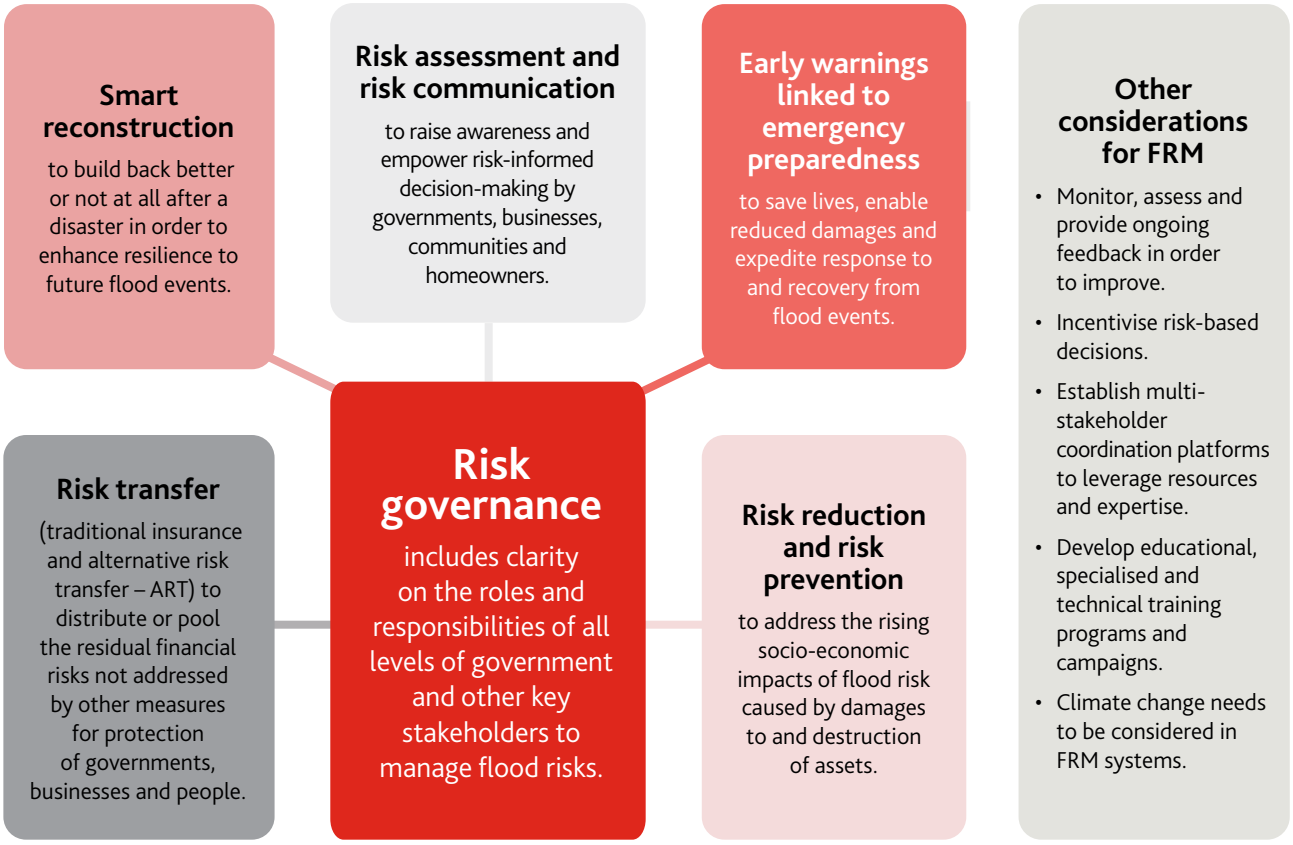
   It is important to note that risk governance goes far beyond the government. Other key stakeholders in the FRM system, for example, public utilities, the insurance industry, banks and mortgage lenders, real estate developers and community-based organisations, have important roles to play.

   Finally, homeowners, communities and businesses need to understand their risks, be incentivised and actively manage their risks.

2. **Risk assessment and risk communication to raise awareness and empower risk-informed decision-making.**

   This includes the availability and accessibility of decision-relevant risk information for target stakeholders; risk information that is produced not only using historical data, but also takes into consideration how the risk may be changing linked to climate change and other socio-economic drivers; and effective communication channels for target stakeholders to increase awareness, understanding and ownership of risk. A common understanding of the levels of risk by key stakeholders is fundamental to identifying and prioritising decisions to manage the risks, such as risk reduction and prevention, risk financing, risk transfer and reconstruction decisions.

Figure 3: Framework for assessing flood risk management systems



Source: The Geneva Association

The ability to assess risk requires access to reliable environmental and socio-economic data. Increasingly governments are revisiting their data policies and investing in national data platforms to make publicly funded data accessible to all.

Furthermore, risk communication is important for risk awareness and enabling risk-informed decision making by homeowners, businesses, communities and the general public. Risk information may be developed and shared not only by governments, but also by a variety of other key stakeholders, such as insurance companies and insurance brokers, banks and mortgage lenders, real estate companies, home inspectors, NGOs and community-based organisations.

3. Early warnings linked to emergency preparedness to save lives, to enable reduction of damages and to expedite response to and recovery from flood events.

Emergency preparedness and early warning systems minimise loss of life (through evacuations and other measures) and enable reduction of damages, by moving valuable assets out of high-risk areas before the event, expediting response to and recovery from flooding events, activating business continuity plans, and speeding up insurance claim payments.

4. Risk reduction and risk prevention to address the rising socio-economic impacts of flood risk caused by damages to and destruction of assets.

Investing in ex-ante measures to reduce existing and prevent new flood risks, by governments, businesses, communities and homeowners, is fundamental to building socio-economic resilience to floods. A key consideration is understanding the drivers of flood risk and the changing landscape over time. Investments in risk reduction and prevention have significant implications for risk financing and the availability and affordability of insurance. The following are some examples:

- **Governments** investing in flood protection infrastructure and natural infrastructure as buffers; adopting sound land-use management practices; updating and enforcing building codes and standards for new homes, buildings, infrastructure and community development; and incentivising retrofits.

- **Businesses** investing in retrofitting their buildings and incorporating risk reduction measures into their enterprise risk management, operations and supply chain management.

- **Communities** (e.g. municipal governments, utilities and local organisations) joining efforts to implement structural and non-structural flood mitigation measures.

- **Homeowners** basing their purchasing decisions on understanding the flood risk; retrofitting their existing homes and/or building new homes by adopting recommended flood building codes and standards (knowledge and affordability may be large hurdles).

- **Banks, mortgage lenders and insurers** offering incentives, such as asset valuation, mortgage rates and insurance premiums, to the owners who implement retrofit measures.

5. Risk financing for protection and management of governments' budget.

This involves innovative ex-ante risk financing and contingency planning for budget protection by combining (or layering) financing instruments that address different needs and have different cost implications (i.e. prioritising cheaper sources of funding, while ensuring that the most expensive instruments are used only in exceptional circumstances). This could include pre-planned budgetary instruments, contingent financing, risk-transfer measures (e.g. insurance risk pools) and insuring public assets (World Bank 2014; The Geneva Association 2017).[8] Furthermore, increased awareness about flood risks, ex-ante financing and contingency planning is also important for small- to medium-size businesses, communities and households, instead of solely relying on post-disaster government assistance.

6. Risk transfer, including traditional insurance and alternative risk transfer (ART), for governments, businesses and households to distribute or pool the residual financial risks that are not addressed by other measures, taking into account affordability, accessibility and relevance to the needs of the stakeholders.

Insurance could incentivise policyholders to take reduction and risk prevention measures. Pricing of risks and affordability of insurance is deeply interlinked to risk reduction and risk prevention measures. Developing sustainable insurance markets requires policies and regulatory regimes to enable the insurance industry to operate in a jurisdiction and to establish distribution channels and mechanisms for timely claims payouts after disasters (The Geneva Association 2016).

7. Smart reconstruction to build back better or not build back at all after a disaster to enhance resilience to future flood events.

This involves better reconstruction, buying-back and re-zoning decisions in very high-risk areas to increase resilience to future events.

8. Other key considerations of the research framework include

a. Capacities to monitor, assess and provide ongoing feedback to improve parts of or the entire FRM system.

b. Mechanisms to incentivise behavioural change towards risk-based decision-making.

c. Multi-stakeholder processes and platforms (e.g. across public and private sectors and community-based organisations) to enhance coordination, engagement and innovation.

d. Formal and informal educational programmes, campaigns, specialised and technical training programmes to increase awareness, expertise and know-how.

e. Integrating climate-change considerations in all aspects of the FRM system.

8 Public assets generally tend to be self-insured. When a disaster such as a flood happens, in the absence of proactive risk financing, a significant portion of post-disaster aid is spent on partially insured or uninsured public infrastructure and buildings (The Geneva Association 2019a).

4. Country-specific trends and findings

This section provides a summary of the key findings of The Geneva Association's country reports on FRM in the U.S., England and Germany (The Geneva Association 2020a, 2020b and 2020c). Readers should refer to those country reports for more details.

4.1. United States

- **Flood risks:** Flooding is one of the most frequent and costly natural disasters in the U.S. The country experiences coastal, fluvial and pluvial flooding. Flood risk is increasing due to escalating heavy precipitation events and rising sea levels caused by climate change, continued development in high-risk areas and ageing infrastructure.

- **Institutional roles and responsibilities:** FRM in the U.S. is a shared responsibility across multiple federal agencies, all levels of government, the private sector and non-governmental organisations. This creates both complementarity and duplication of efforts and some gaps in FRM remain.

- **Legislative action:** The approach to FRM in the U.S. has shifted over the past century from a focus on structural protection to building flood resilience through various approaches. The 1927 Mississippi River floods catalysed the first legislative initiatives on structural flood protection. Over the following decades, thousands of miles of levees, hundreds of dams and many other forms of structural protection were constructed. Fifty years ago, Congress broadened FRM to include non-structural measures with the creation of the National Flood Insurance Program (NFIP).

- **Risk information and communication:** At this time, nationwide, freely available flood risk information is available from the Federal Emergency Management Agency's (FEMA's) NFIP, in the form of Flood Insurance Rate Maps (FIRMs). However, these maps are not ideal products for risk communication and critics contend that they create a false perception of flood risk, are often outdated and do not fully capture storm-water flooding. Beyond FEMA's maps, there are substantial amounts of flood risk data in the U.S., along with multiple flood models produced by the government, academics and private sector firms. Navigating and understanding this information, however, may be confusing, particularly for less sophisticated users. Communities and households may not have access to relevant information to support their decisions. This can distort the housing market and lead to suboptimal decisions. Further advances in providing useful and decision-relevant risk information are needed.

- **Alerts and early warnings:** The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) issues forecasts, warnings and advisories for weather and water-related hazards to communities across the U.S. Flood warnings originate in one of 122 Weather Forecast Field offices and are sent directly to residents' cell phones and communicated via the web, television and radio.

- **Emergency preparedness:** Flood warnings and advisories are used by local governments to make decisions about evacuations, school closures, deployment of first responders and other measures to protect lives and property. State and local governments generally have evacuation protocols in place that specify how the decision-making and evacuation processes should occur.

- **National Flood Insurance Program (NFIP):** The NFIP is the primary non-structural approach to FRM in the U.S. Communities join the program voluntarily, by adopting minimum floodplain management regulations. In exchange their residents become eligible to purchase flood insurance from the federal programme. However, many of those at risk are still not insured. Public policies to help close the flood insurance gap are being explored. Some families do not have the resources to afford flood coverage and multiple stakeholders have suggested that a federal means-tested assistance programme could help lower- and middle-income families with the cost of insurance.

Congress has not designed the programme to be financially sound and the NFIP is billions of dollars in debt to the U.S. Treasury. The programme has secured flood reinsurance protection from the capital markets twice by issuing CAT bonds in 2018 and 2019 and is seeking further protection with its third CAT bond issuance in January 2020. However, the programme is in critical need of financial reform.

- **Risk reduction:** Federal funding for flood mitigation is offered through a variety of agencies and programmes. These federal dollars for risk reduction are typically provided post-flood, off-budget, tied to major disaster declarations after large flood disasters and targeted at the impacted areas. There are indications of a recent shift toward allocation of more federal dollars for risk reduction pre-disaster. It is difficult to engage policymakers and other stakeholders in long-term strategic planning and investment for risk reduction and prevention. National forward planning to address increasing flood risks from climate change has also been difficult in the current political environment. Local interest in and approaches to flood risk reduction vary significantly around the country.

- **Post-disaster response:** Post-disaster federal aid to households is limited, and low-income families seldom get full support for financial recovery. Federal disaster aid for local governments, however, is generally more generous. Local governments are therefore not incentivised to use and manage risks in floodplain lands responsibly, and the costs for flood damages are funded by federal taxes and taxpayers.

- **Overall FRM approach:** Further progress on FRM is hindered by a lack of common incentives, affordability constraints, insufficient political will for long-term planning and inadequate investment in retrofitting and upgrading ageing infrastructure. Increasing flood risk, particularly in coastal areas, poses significant future challenges that should be considered now in building and land use decisions. Overall, despite the developments highlighted in this report, the FRM system in the U.S. continues to remain, in general, reactive to floods, pointing to the need for a more cohesive, systems-based forward-looking approach that takes into consideration the impacts of climate change. Furthermore, a process for monitoring and evaluating FRM is needed in order to improve the system.

An overview of the FRM system in the U.S. (pre-1950–2019) and its evolution are provided in Annexes 2a and 2b, respectively.

4.2. England

In the U.K. there is no single body responsible for FRM. Significant legislative and policy responsibilities were delegated from the U.K.'s central government to the administrations in Scotland, Northern Ireland and Wales during the U.K.'s process of devolution in the late 1990s. Recognising these regional differences, this study focuses on FRM in England only.

- **Flood risks:** Fluvial, coastal, pluvial and groundwater flooding occur regularly, causing damage and losses to communities, businesses and households. Climate change and socio-economic trends are expected to increase risk.

- **Flood events:** The 1952 coastal floods and 2007 summer floods across wide areas of the country stand out as key events that triggered shifts in perception and FRM responses. Winter floods in 2013/14, 2015/2016 and 2019 have led to calls for more investment and growing recognition of the need for an approach that focuses on both resilience and protection.

- **Institutional roles and responsibilities:** FRM entails a range of policies, interventions and activities, delivered by a variety of stakeholders. The approach to FRM is shaped by policy, legislation and other informal rule systems. The Department for Environment, Food and Rural Areas (DEFRA) has overall policy lead, and the Environment Agency (EA) is the main operational body.

- **Legislative action:** Several key pieces of legislation shape FRM governance, including the Civil Contingencies Act (2004), the Flood Risk Regulations (FRR) 2009 and the 2010 Flood and Water Management Act (FWMA). Regular lessons-learned reviews offer important insights, but recommendations are often not implemented.

- **Risk information and communication:** Risk information capability and data accuracy are strong and flood forecasting is highly developed in England, but use of that information and the level of general flood risk awareness remain low. Problems, stemming from different approaches to flood risk mapping and assessment in Scotland and England, cause challenges for stakeholders with cross-border perspectives, such as insurers for their risk management and underwriting purposes.

- **Alerts and early warnings:** Tools and innovative approaches for alerting stakeholders exist. Flood risk information is currently produced and communicated by the Flood Forecasting Centre (FFC), a partnership between the U.K. Met Office and the EA.

- **Emergency preparedness:** Flooding is treated as part of a broader 'emergency' civil protection policy as per the Civil Contingencies Act 2004. DEFRA maintains the National Flood Emergency Framework for England (HM Government 2016a) and Lead Local Flood Authorities (LLFAs) play a key role in emergency planning and recovery after a flood event.

- **Risk reduction:** The government is investing in FRM, but funding continues to pose a challenge, particularly at the local level. New funding types and sources are being tested across all levels of government.

- **Property-level protection:** Uptake remains low despite growing recognition of effectiveness. Some measures are funded by homeowners or developers and financial support in the form of grants is available.

- **Planning and land use:** The planning system recognises the need to consider flood risk when granting new permissions for development, but growing pressure on housing and land use creates challenges for those tasked with land zoning and local planning decisions. It has been pointed out that some aspects of the planning system, for example sustainable urban drainage, need updating to better align with FRM aims.

- **Risk finance:** Insurance, budgetary tools and funds such as the Bellwin scheme are the main sources of funding for recovery and reconstruction.[9]

- **Risk transfer and insurance:** Traditionally, the approach to FRM has been risk-based rather than solidarity-driven, with a strong reliance on insurance to finance losses. Insurance penetration levels are comparatively high, with cover provided by the private market, but concerns about affordability led to the creation of a subsidised pool solution known as Flood Re. However, the pool is only available to residential properties built before 2009.

- **Reconstruction:** Significant financial efforts, funded by insurance and public funds, support speedy recovery and reconstruction, but there is very limited evidence of 'building back better' and factoring resilience into reconstruction.

- **Multi-stakeholder engagement:** Integrated community-level risk management is still developing; however, specific roles and responsibilities are often unclear due to the many actors involved in FRM. Cross-sectoral collaboration exists, but more targeted incentives are necessary to engage all parts of society. The real estate, banking and investment sectors have not fully recognised the importance of flood risk and there is a systemic risk of over-reliance on the future availability of insurance.

- **Overall FRM approach:** There is clear evidence that FRM in England has shifted from hazard management, focusing on flood control measures such as flood defense and drainage systems, towards a much broader approach that embraces a range of tools and instruments and acknowledges that we cannot eliminate all risk. However, despite growing recognition of the need for wider resilience, there is still an over-reliance on structural flood protection. Improving the resilience of infrastructure, housing and land use and the implications of climate change are key challenges for FRM in England. Climate change considerations are integrated into FRM and long-term planning by the EA. The insurance industry and government have a track record of collaboration on FRM, but the new pool, Flood Re, was not designed to help build long-term flood resilience. Flood Re has now identified the need for a resilience strategy as part of its transition policy.

An overview of the FRM system in England (pre-1950–2019) and its evolution are provided in Annexes 3a and 3b, respectively.

4.3. Germany

- **Flood risks:** Germany is exposed to coastal, fluvial and pluvial flooding, particularly in urban areas where localised surface water and urban flash floods are an area of growing concern.

- **Flood events:** Major flood events, including storm surge in 1962, river flooding in 2002 and 2013 and more recent flash floods, have shaped Germany's approach to FRM.

9 The Bellwin scheme (initiated in 1983) is funded by the central government and provides financial assistance for unexpected losses to local authority functions (Department for Communities and Local Government 2011). It covers uninsured losses inflicted by perils such as flooding, extreme weather and major fires, for example the cost of emergency procedures and repairs faced by local authorities (Alexander et al. 2016).

- **Institutional roles and responsibilities:** The federal political system distributes flood risk responsibilities across levels of government and various stakeholders, which can result in different management approaches. FRM is therefore fragmented with no clear champion with the remit to coordinate between different agencies, sectors and tiers of government.

- **Legislative actions:** Recurrent high-impact flooding has attracted increasing political attention and led to pieces of legislation addressing flood risk, underpinned by systematic reviews after major flood events in 2002 and 2013 (conducted by the German Committee for Disaster Reduction (Deutsches Komitee für Katastrophenvorsorge e.V., DKKV)) and the 2016 flash floods in southern Germany.

- **Risk information and communication:** Various stakeholders provide flood hazard and/or flood risk maps, which differ in content and methodology. Publicly available risk information is not specifically tailored for different end-users. The insurance industry (led by the German Insurance Association, Deutsche Versicherungswirtschaft (GDV)) produced the first countrywide flood hazard zoning system (ZÜRS) in 2001, which has since been extended. Data protection and privacy concerns are current challenges for flood data and knowledge sharing while political pressures around land use and development hinder the use of risk zoning in maps. The GDV, in cooperation with a science-based institute, has also developed a Germany-wide heavy rainfall hazard zoning map, derived from topography characteristics. This is already available for the insurance market and is being discussed and tested with the relevant committees and municipalities for flash flood and surface water flood prevention in Germany.

- **Alerts and early warnings**: All water-related issues and civil protection and emergency management services are managed at the state level. Therefore, the organisation of flood forecasting, warning and civil protection differs throughout the country. Technological advancements have significantly improved the quality and lead times of warnings in recent decades.

- **Emergency preparedness:** At the local level, fire brigades, ambulance services and relief organisations are responsible for smaller and less severe events on a regular basis. At the federal level, as required by law, the Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK) regularly undertakes risk analysis for civil protection from different hazards and publishes the results in parliamentary reports.

- **Risk reduction:** Multiple approaches to reducing flood risk currently exist. The extensive structural flood defences in place—dikes, levees and other water control infrastructure systems—are financed, owned and operated by the federal states, municipal water authorities and dike associations. There is no federal database to track investment in risk reduction.

- **Property-level protection:** According to the Federal Water Act of 2009, property owners are responsible for protecting their property from flooding, for example through the implementation of property-level mitigation measures (PLPMs). Despite a lack of state-run programmes that financially support property-level mitigation, incentives such as insurance and the recently introduced 'flood passport' (Hochwasserpass) should help to systematically improve property-level risk reduction. Overall, there is a growing uptake of PLPMs by property owners.

- **Planning and land use:** The Flood Control Act and second Omnibus Flood Control Act (2018) have helped improve recognition of flood risk in land zoning and planning. Stricter building codes in the one-in-hundred year flood zones and new regulations for the use of flood-prone areas outside statutory inundation areas have been introduced, although the effectiveness and implementation of these new rules are still unclear.

- **Risk finance:** Germany is committed to risk-based compensation through private insurance, while support via ad-hoc state funds was available for those impacted in the past. These state funds have been reduced and are currently only used to provide support in case of hardship. There is currently no regulation that mandates federal, state and local governments to protect their assets from flooding through specific insurance schemes, and uptake of insurance by local authorities is very low. However, state governments increasingly request flood insurance of municipal assets as a condition for receiving any additional government disaster relief payouts.

- **Risk transfer and insurance:** Insurance is provided by the private market and uptake is voluntary. Fluctuating demand and strong regional differences in insurance penetration have in the past led to policy discussions about the need for a mandatory system. Information campaigns and changes in state compensation have contributed to a recent increase in insurance penetration to around 41%.

- **Reconstruction:** Large-scale government aid and insurance payouts mean that reconstruction tends to be quick, but there is limited evidence of 'building back better' and improving resilience in reconstruction.

- **Multi-stakeholder engagement:** Several efforts have been made to increase cross-sectoral and cross-governmental collaboration, but these have been limited to a small number of actors. Property developers or the private sector, for example, tend to be mostly absent from FRM discourse. Collaboration between the insurance industry and government is helping to provide risk information and increase awareness.

- **Overall FRM approach:** Overall, there is evidence that FRM in Germany is shifting towards a more anticipatory and coordinated system, at least on paper. However, links between FRM and climate adaptation planning do not appear to be formalised. The 2002 floods marked a reorientation towards an integrated FRM system in Germany, but the overarching focus remains on maintaining standards instead of enhancing wider resilience. Data mapping and modelling for surface water flooding is still lagging and legally evolving (e.g. data protection laws, possible liability claims against local authorities).

An overview of the FRM system in Germany (pre-1950–2019) and its evolution are provided in Annexes 4a and 4b, respectively.

5. Overall trends and key findings

This section summarises trends and lessons learned from the three country case studies.

Flood risk: Flood risk is a concern in all three countries. Flood risk is impacted by changes in exposure, vulnerability and hazard characteristics; for example, increasing concentrations of people and assets in high-risk zones and the increasing frequency and severity of flood-related events linked to climate change. Localised urban and storm water flooding is an area of growing concern in all countries.

The rising socio-economic impacts of floods have become a national concern in all three countries, particularly in the immediate aftermath of flood events. All three countries are impacted by fluvial floods (river floods), pluvial floods (flash floods and surface water) and coastal floods (storm surge).

Recurrent high-impact flooding has led to growing political, public and insurance industry concern about the need for action to reform FRM systems and to strengthen flood resilience. Although it is increasingly accepted that some degree of flooding risk is inevitable, much could be done in the way of risk prevention, risk reduction and preparedness, including access to adequate insurance.

In fact, generation flood risks are impacted by the actions – or inactions – of numerous stakeholders. Examples are highlighted in Table 2.

Cahill's Crossing, Kakadu National Park, Northern Territory, Australia

Table 2: Stakeholder influence on flood risk		
Stakeholder		**Actions to mitigate flood risk**
Homeowners		• Location decision for home purchase • Risk-reduction and retrofit investments (e.g. elevating homes, retrofitting pipes and sewage and drainage systems and moving valuable assets to higher levels) • Percent of lot that is pervious • Insurance decisions
Businesses		• Location decisions • Risk-reduction and retrofit investments • Insurance decisions
Governments	**Local**	• Land-use regulations and issuance of building permits in high-risk zones • Update and enforce building codes • Community-level risk reduction investments (e.g. levees, green infrastructure) • Citing infrastructure and public buildings • Incentive programs for property owners to mitigate flood risk • Funding for mitigation • Flood-risk communication programs
	State	
	National/federal	• Flood-hazard/risk mapping • Flood-risk communication programs targeted at officials and decision-makers, businesses, homeowners, etc. • Floodplain management standards, pricing and incentives • Cost-shares and requirements for flood-risk reduction infrastructure • Insurance requirements • Post-disaster aid funding and reforms to incentivise ex-ante risk reduction – amounts and requirements
Levee districts		• Funding and constructing levees and other flood-risk reduction infrastructure
Utilities		• Flood-proofing structures and distribution system • Water management systems such as sewage and drainage
Banks and mortgage lenders		• Insurance requirements • Risk-based loan terms in high-risk areas
Real estate developers		• Citing decisions • Risk-reduction and risk-prevention investments (e.g. updated building codes) • Sewage and drainage projects
Critical infrastructure operators		• Citing decisions • Flood-protection and risk-reduction measures

Source: The Geneva Association (2020a)

Institutional roles and responsibilities: In general, approaches to FRM are slowly evolving from efforts to control water to building resilience to floods. Countries are increasingly taking a more risk-based and collaborative approach to FRM. Protecting the most vulnerable citizens remains a critical issue for the governments, but they cannot tackle this problem alone. Increasingly, FRM requires shared responsibilities.

FRM entails policies, interventions and activities delivered by numerous stakeholders with different incentives and priorities, creating complementarities as well as duplication and sometimes gaps in efforts. In general, most stakeholders are reactive to events, rather than anticipatory. There is also significant room to leverage and coordinate resources and efforts.

The evolution of FRM in the three countries differs significantly, driven by a variety of country-specific factors:

- Types and impacts of flood risks
- Each country's governance structure
- Overall strategy, policies, regulatory frameworks, institutional arrangements, coordination and dynamics within and across layers of government to address FRM
- Institutional and cultural legacies associated with FRM evolution
- Extent of engagement and dynamics between public and private sectors (with insurance, banking, development and real estate)
- Availability and accessibility of decision-relevant risk information for all members of the society
- Overall risk awareness, risk perception and ownership across society
- Priorities for action in the FRM system (e.g. post flood response, ex ante risk reduction, insurance)
- Societal perceptions and government's approach about post-disaster aid (i.e. 'government will pay') versus protection through insurance
- Climate-change considerations, which are often deeply connected to the politics of the country.

Risk information and communication: In the last decade, the need for flood-risk assessment and communicating risks has gained significant momentum, albeit with different levels of success and impact on decision-making. Although many shortcomings and challenges remain, flood risk information is increasingly available to the public, not only from governments, but from the insurance industry, other private-sector organisations, NGOs, research and academic organisations and others. The extent to which risks and risk information are factored into decision-making varies among stakeholders, and in many cases, risk information is not decision-relevant; for example, for local governments and homeowners.

Alerts and early warnings: The three case studies confirm significant progress toward implementing early-warning systems linked to emergency preparedness systems in order to mitigate threats to lives and livelihoods. Civil protection authorities are utilising the latest technologies to improve the quality, lead-time and distribution of flood alerts and warnings as well as response operations. Insurance companies are also using these technologies to expedite post-disaster assessment and claims payouts.

Risk reduction and risk prevention: The need for ex-ante investments in risk-reduction and risk-prevention measures by governments, businesses, communities and homeowners is slowly coming into focus in all three countries. However, quality of implementation varies, with different priorities, approaches and levels of coordination among agencies and levels of the government. These measures also drive affordability and sustainability of insurance.

There appear to be perverse incentives in all the countries, particularly with the government agencies responsible for land-use planning and building-code decisions, that may limit actions to reduce and prevent risks. These are often driven by financial incentives to allow risky development, since local governments may benefit from the tax revenue but pay little of the costs when a flood occurs. On the other hand, reasons for inaction also include resource needs and lack of access to reliable risk information and expertise, as well as the need to align priorities and better coordinate with other municipalities and state and federal/national agencies. There are exceptions; some municipal governments have improved their approaches and can provide models for best practices in their country.

Risk financing: Risk financing and contingency planning for protecting government budgets is gaining attention, particularly at the national level. However, despite the recurrence of high-impact flooding events in the three countries, governments have not established pre-disaster budgets and contingency plans, and funds need to be appropriated through a legislative process after an event.

Some governments recognise the need to reform post-disaster, government financial assistance. The potential for improvement is deeply linked to the political environment.

Risk transfer (insurance and alternative-risk transfer): Beyond providing financial protection, the insurance sector in some countries further demonstrates its value proposition through its flood-risk analytics and modelling capabilities, flood-risk communication and awareness campaigns, and programmes that incentivise- risk-reduction and risk-prevention measures. However, the sustainability and affordability of insurance products deeply rely on the ex-ante efforts of governments to invest in risk-reduction and risk-prevention measures. Furthermore, limited take-up of insurance is linked to low levels of risk awareness, understanding of the benefits of insurance and knowledge of the potential impacts of floods and downsides to relying on support mechanisms like post-disaster government handouts. Alternative risk transfer solutions, such as CAT bonds, allow businesses to seek further protection from the capital markets.

Collaboration between governments and the insurance industry can promote the accessibility, affordability and sustainability of insurance as a key element to enhance flood resilience. Governments and the insurance industry need to commit to working together towards promoting and incentivising risk reduction and risk prevention and to achieving mutually agreed definitions of their respective roles.

Reconstruction: There is growing recognition of the need to build back smarter after an event in order to strengthen resilience to future events in medium- and high-risk regions and for clear guidelines on how to build. However, meaningful action from those involved in the recovery and reconstruction process has been limited. Decision-making does not sufficiently factor in the changing risk landscape, particularly related to climate change. Decisions to not build back at all and/or move people and businesses away from very high-risk regions are politically charged.

Multi-stakeholder engagement: Cross-sectoral and multi-stakeholder collaboration and initiatives are proving to be highly beneficial, although efforts are needed to develop and sustain such mechanisms for ongoing engagement beyond awareness raising and towards real action. A variety of examples are highlighted in all the three case studies; however, there are significant opportunities to develop and strengthen such mechanisms as a way to coordinate, align priorities and leverage resources and expertise to develop sustainable solutions and scaled-up actions.

Overall FRM approach: Despite some progress, FRM systems remain, in general, reactive to floods. Furthermore, all three countries shouldinvest in monitoring the impacts and benefits of investments in risk awareness and communication, risk reduction and risk prevention in order to improve their systems overtime. Instead, these efforts happen after a disaster, in the context of retrospective reviews and audits, to generate recommendations for improvements. It is critical for economic-development and climate-adaptation strategies at all levels of government to prioritise forward-looking approaches to building flood resilience and FRM.

6. Recommendations for the way forward

As FRM is a multi-faceted challenge, it is important that the many stakeholders involved have clearly defined roles and responsibilities and an understanding of the motivations and incentives behind them in order to collaborate effectively. Shifting towards a more anticipatory FRM approach requires behaviour changes, not only from those tasked with managing risks, but also those at risk or involved in creating risks. This can only be achieved through enhancing societal risk awareness, adopting a systems-based thinking and enabling inter- and intra-sectoral engagement. This shift is particularly critical in the face of climate change and other emerging risks and as the world grapples with managing the health and socio-economic impacts of the COVID-19 crisis.

Governments

Recommendation 1: Governments should *develop clear national strategies for FRM*, with an anticipatory, cohesive and systems-based approach to building flood resilience. This should be an integral part of economic development and climate change adaptation plans. They should establish effective mechanisms to leverage strengths, expertise and innovative solutions from key stakeholders, particularly the private sector. The following are specific recommendations:

1. Adopt an approach that builds on the strengths of all stakeholders, including the public and private sectors, community-based organisations and NGOs; move from reactive to proactive approaches that consider the changing risk landscape caused by climate change and other socio-economic drivers.

2. Consider that FRM entails a variety of highly interdependent measures, including risk assessment and risk communication, risk reduction and prevention, risk financing, risk transfer and building back better after an event (refer to section 2). In this regard, they should

    a. Play a large role in developing and communicating flood-risk information to the general public and investing in risk reduction, risk prevention and smart reconstruction measures

    b. Ensure that roles and responsibilities for the relevant agencies at the federal, state and local levels are clearly established and that the agencies are adequately resourced (expertise and funding)

    c. Establish mechanisms within and across layers of the government to support coordinated implementation

3. Establish mechanisms for effective engagement with the private sector, particularly with the insurance industry, banks and mortgage lenders and other relevant financial institutions, to leverage their risk assessment and risk management expertise to do the following:

    a. Enable risk-based financial incentives for implementing risk reduction and risk prevention measures

    b. Develop sustainable insurance and other financial solutions for protection of homeowners, businesses and the government budget

4. Reform their post-disaster aid programmes to incentivise flood-risk reduction and prevention measures, prioritising measures for the most vulnerable population. They should promote and encourage citizens and businesses to protect themselves without relying on government assistance.

5. Make disclosure of previous flood events mandatory from the early stages of property-purchasing decision to inform buyers about previous flood events and actions taken by owners.

6. Establish mechanisms to improve the FRM system and its components overtime by

    a. Monitoring and evaluating the impacts of FRM measures and the effectiveness of coordination mechanisms and identifying gaps and challenges

    b. Developing feedback mechanisms to improve the FRM system

Insurance industry

Recommendation 2: The **insurance industry** should *increase their proactive engagement with governments and their customers*, as risk advisers, risk management experts, risk underwriters and investors to support the implementation of FRM systems to strengthen resilience to floods. The following are specific recommendations:

1. National insurance associations should work with their members to find mechanisms for effective industry-level engagement and collaboration with government authorities. This could include sharing risk information, providing risk management advice, engaging in risk awareness campaigns and, together with the government, developing practical and sustainable solutions to enhance socio-economic resilience to floods.

2. Through industry-level platforms, industry associations and individual companies:

    a. Raise risk awareness by communicating flood-risk information among the general public, businesses, communities and all levels of the government.

    b. Invest in bilateral and multilateral flood-risk reduction and prevention research in areas such as the root causes of flood risk; solutions for home-, building-, infrastructure- and community-level flood retrofits; and updating building standards and codes.

    c. Translate research findings into actionable guidelines and share these publicly with homeowners, businesses, communities and governments.

    d. Promote the systematic collection and availability of publicly-funded environmental and socio-economic data for flood risk modelling.

    e. Support the development of forward-looking flood risk models that incorporate climate change, leveraging the latest climate-change science and engineering developments.

    f. Offer innovative customer-relevant insurance and alternative risk-transfer products (e.g. CAT bonds, resilience bonds, etc.) that incentivise risk-reduction measures.

3. Insurance companies, in light of TCFD developments, should do the following:

    a. Evaluate the impacts of changing flood risks (as part of assessing physical climate risks) on both sides of their balance sheets – liabilities and investments.

    b. Offer their risk-modelling and risk-management advice to commercial clients for adopting TCFD recommendations and offer clients innovative solutions to help reduce and manage physical climate risks.

Businesses and households

Recommendation 3: Businesses and households should proactively seek flood-risk information; *understand and take responsibility for managing their flood risk*; and make risk-informed decisions. Specifically,

1. Seek out authoritative, publicly available flood-risk maps and information.

2. Inquire with their local governments, insurers, insurance brokers, home inspectors, banks and mortgage lenders and utility companies about incentives and guidelines from them on FRM.

3. Explore whether there are loans and grants available through their local governments for retrofitting their properties.

4. Request information from previous owners, real estate brokers or developers about the history of their property and previous retrofit measures undertaken prior to their purchase.

5. Understand whether the risks of pluvial, fluvial and coastal floods are covered by their standard insurance, and if not, purchase flood insurance that does cover them.

International organisations and academic institutions

Recommendation 4: International organisations, academic institutions, professional and executive education programs could utilise this study in their awareness-raising campaigns and educational programmes targeted at government officials, policy makers, businesses and the general public, *promoting the need for a risk-based anticipatory, cohesive and systems-based approach*, which takes climate change into consideration for building flood resilience.

FRM stakeholders in the U.S., England and Germany

Recommendation 5: Government officials, the insurance industry and other stakeholders responsible for FRM in the U.S., England and Germany should come together in their respective countries to *review and discuss identified gaps, challenges and weaknesses* identified in this study and find effective ways to work together to enhance their FRM system towards a more cohesive, systems-based and forward-looking approach. National insurance associations could play a key role to convene these stakeholders.

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Annex 1: Questions used to map and analyse the evolution of flood risk management

1. **What is the evolution of flood risk in the country?**

    a. What are the types of flood risk, who is at risk and why?

    b. What are the underpinning causes of flood risk?

    c. What are the socio-economic impacts?

    d. Is flood risk growing? What are the drivers of rising flood risk in the country?

    e. Has addressing financial and social risks associated with floods become a national concern for people, businesses and the government? In what ways?

2. **Is reliable flood risk information available and accessible to support decision-making?**

    a. What are the underpinning data sources for flood risk analysis (hazard, exposure and vulnerability)?

    b. Are there official flood risk maps and are they publicly available? What types of information are being developed? What are the strengths and weaknesses of the official flood risk maps? How often they are updated?

    c. Are there other sources of flood risk information? Who is processing and providing flood risk information? What types of information is being developed? To whom is this information provided? How is this information provided to target stakeholders?

    d. Is flood risk information provided to target stakeholders? E.g. people, businesses, community organisations, different government agencies, local government and utilities? Are these maps decision-relevant?

    e. Has the level of risk (e.g. high, medium, low) been identified in different regions? Is this information used to zone the regions according to the level of risk? What are the fundamental assumptions?

    f. Are there targeted risk communication programmes? If yes, who provides them?

    g. What are the benefits, challenges and concerns associated with available risk information and the way it is being provided?

    h. What is the level of flood risk awareness in the country among different stakeholders? Is risk information impacting decisions (e.g. by people, businesses and government)?

    i. Are there any mechanisms for monitoring, assessing and incorporating the changing risk landscape (hazards, exposures, and vulnerability) in the risk maps? Are the underpinning causes of the changing risk landscape investigated and monitored (e.g. climate change, development patterns and practices?) What are the main challenges and concerns?

3. **How is FRM governed in the country, and how is it evolving? How are different stakeholders engaged in the system?**

    a. Who are the key stakeholders with official responsibility to manage floods and their impacts?

        i. Who has official responsibility for FRM in the country? Is this reflected in national to local legislative processes (e.g. government at national, state and local levels, the insurance sector, banking and mortgage lenders, public utilities, the media, NGOs and other community-based orgs, homeowners)? What are their roles?

        ii. Who is responsible for addressing the needs and challenges faced by the most vulnerable groups of the population?

iii. What is the perception of homeowners, businesses and other stakeholders in terms of who is responsible? Does the existing system require that homeowners and business owners manage their own flood risks? Please describe.

4. **What is the approach to risk reduction (existing risks) and risk prevention (new risks), particularly in relation to rising risks associated with climate change and other socio-economic drivers?**

   a. Is FRM considered an integral element of socio-economic planning, budgeting and development in the country? Is FRM an integral element of climate adaptation policies and decisions, as opposed to being a stand-alone objective?

   b. Have (or are) disaster risk reduction and risk prevention plans been (or being) developed, implemented and supported/enforced by public policy and regulatory frameworks (at all levels of government)?

      i. Who is responsible for development and implementation of these measures? Are the interlinkages of these measures considered part of the overall development and risk management strategy? Or are they implemented in isolation?

      ii. Is there a dedicated budget supporting these plans? How is the budget allocated between levels of government?

      iii. Are there incentive mechanisms to promote and enable the implementation of risk reduction and risk prevention by different stakeholders (homeowners, businesses, community-based organisations, local, state and federal governments, public and private utilities, etc.)?

      iv. Is there a process for monitoring and evaluating the impacts of these measures to improve them over time (what level, by whom, how)? For example, monitoring the impact of retrofitting for residential homes, businesses, government assets, infrastructure (public or privately owned) and communities; or the impact of floods on homes and buildings built based on new building code standards versus old ones?

5. **Are early warning systems and emergency preparedness in place and if so, how is this helping to reduce risks (reducing loss of life, livelihoods and economic damage)?**

   a. Who is responsible for developing and issuing the alerts and warnings? Are these warnings accessible, understood and responded to by different stakeholders?

   b. Who is responsible for ensuring alerts and warnings are linked to emergency preparedness on the ground?

   c. What is the receptivity of the general public, businesses and communities to these warnings?

   d. Are warnings leading to increased risk awareness, reduction of property damage and expedited response to and recovery from flooding?

   e. What types of actions are being taken by government (at all levels), businesses, communities and people, based on warnings, to reduce risk?

6. **Are those that are directly impacted by floods incorporating risk financing and contingency planning in their budgets and plans to increase financial resilience and expedite their ability to respond to floods (e.g. government (all levels), businesses, people)?**

   a. Is the government taking a strategic approach to its financial protection by combining financial instruments? E.g. prioritising cheaper sources of funding, ensuring that the most expensive instruments are used only in exceptional circumstances, using pre-planned budgetary instruments, contingent financing and risk transfer measures (e.g. risk pools) and insuring public assets?

   b. How has post-disaster aid funding been approached and appropriated?

   c. Does the country remain reactive (focused on post-disaster response and recovery) or is it strategically considering the need to build resilience to reduce current risks and prevent new risks? Describe in more detail with examples.

   d. Have post-disaster aid programmes undergone any reforms or modifications to incentivise and/or enable risk reduction and prevention and help with the expansion of insurance for the protection of people, businesses and government?

e. Does the government arrange for any contingency plans to protect its budget to ensure access to cheaper funds in case of disasters?

7. **Is there an active flood insurance market in the country? Is the value proposition of the insurance sector leveraged in building flood resilience in the country? Is the value proposition of the insurance sector understood by governments, businesses and people?**

   a. What is the status of insurance in the country? Is it provided as a national government service, through the private insurance market or as a combination (public–private partnerships, PPPs)?

   b. What is the nature of the insurance programmes (insurance pools, integral part of home insurance or separate insurance products)? Is the insurance delivery:

      i. Risk-based?

      ii. Mandatory versus voluntary?

      iii. Incentivising risk reduction through reduced premiums or other mechanisms (please describe)?

      iv. Aimed at residents, SMEs, businesses, government?

      v. Market-based or enabled through policies and regulatory frameworks (if so, how)?

   c. Is there insurance-backed securitisation of CAT and green bonds?

   d. What is market penetration and coverage?

   e. Is the insurance programme sustainable?

   f. What is the receptivity of government in engaging with the insurance sector?

   g. Is the insurance industry proactively engaged with government and other stakeholders to address strengthening of flood resilience? Please describe.

      i. Is the insurance industry engaged with government in reviewing flood risks to residents, business, government, and infrastructure and identifying innovative market-based solutions?

      ii. Is the insurance industry developing innovative risk transfer measures (with or without collaboration with the government?). Are these solutions available, accessible and affordable and are they being used by those at risk to distribute or pool the residual economic risks?

      iii. Are insurance solutions (by industry, government or both) incentivising behavioural change (e.g. insurance solutions available to residents, SMEs, etc.)?

   h. Are the government (at all levels) and/or the insurance industry engaged with customers and businesses to educate about risks, preventive mechanisms and the benefits of insurance?

8. **Following a disaster, are there systematic mechanisms to revisit, re-evaluate and decide on reconstruction plans and decisions?**

   a. Are there formal mechanisms and legislation in place to enforce the need to build back smarter (e.g. build back using updated building codes, relocate and do not build at all if the region(s) has been identified as a high-risk zone)?

   b. Are there efforts to reconsider land zoning in high-risk regions that experience recurrent risks? Are there any government plans for buyouts and relocation from high-risk zones? Have these programmes and their impact been assessed?

9. **Are there monitoring and review processes in place for assessing/measuring the impact of risk communication, risk reduction, risk prevention, risk financing and risk transfer decisions and for providing feedback to improve the different components of FRM in the country?**

10. **Overall:**

    a. Is the FRM approach transitioning toward a greater focus on flood resiliency? E.g. is the approach focused not only on reducing current risks but also prevention of future risks linked to factors such as climate change?

    b. Is the approach characterised as fragmented (i.e. engaging many organisations with different but disconnected roles and initiatives) or is it evolving towards a holistic all-of-society approach (leveraging all components of the system)?

    c. Is there any evidence of cultural/behavioural change towards active management and reduction of risk (e.g. people, businesses, communities and all levels of government)? Is it linked to the level of risk? Are there incentives for this change?

Annex 2a: The flood risk management

Post-disaster response and reconstruction

- Federal involvement in post-flood recovery and reconstruction is governed by the Robert T. Stafford Emergency Relief and Disaster Assistance Act of 1988 (Stafford Act). Under the Act, the President can authorise federal assistance programs when the expected costs for recovery from a disaster exceed state and local governments' fiscal capacity.
- Post-disaster aid is administered through FEMA, the Small Business Administration, Department of Housing and Urban Development, Internal Revenue Service and U.S. Department of Agriculture.
- Post-disaster federal aid to households is limited, and families seldom get full support for financial recovery.
- Federal disaster aid for local governments is generally more generous, raising questions about possible perverse incentives.

Risk assessment and risk information

- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)
- U.S. Geological Survey (USGS)
- State and local governments
- Non-profit groups and academic institutes
- Private risk-modelling firms

Risk governance

- Responsibility is shared among multiple federal agencies, state and local government, the private sector and non-governmental organisations.
- Congress authorises federal spending on risk mitigation and recovery programmes.

Risk financing

- Congress appropriates dollars to federal risk reduction and recovery programmes.
- The NFIP has been seeking reinsurance and cat bonds to transfer the risk to reinsurers and capital markets.
- Residents with a mortage from a federally regulated lender on a property in a 100-year floodplain are required to purchase flood insurance for it.

Risk reduction and risk prevention

- Grants or incentives are provided by the NFIP, FEMA, the U.S. Army Corps of Engineers, among other federal agencies, and state and local governments.
- Over 90% of all federal dollars are appropriated in off-budget supplemental legislation tied to particular disasters, with much less appropriated pre-disaster.
- There are many areas at risk of flooding where the risk is not actively addressed.

Source: The Geneva Association 2020a

system in the United States

Risk communication

- Federal disclosure law for lenders
- Federal government programmes
- Local government programmes
- Risk awareness is highly varied within and across stakeholder groups
- State hazard disclosure laws

Early warnings linked to emergency preparedness

- The authoritative source is NOAA's National Weather Service originating from 122 field offices and shared via radio, TV, the web and cell phones (may also be packaged and delivered by private firms).

Risk transfer

FEMA's National Flood Insurance Program (NFIP), created in 1968, is the primary non-structural approach (FEMA)

Characteristics and history of the NFIP:

- Communities need to adopt minimum floodplain regulations and then residents are eligible to purchase flood insurance.
- Residential properties can be insured for up to USD 250,000 for the building and up to USD 100,000 for the contents. A business can insure both structure and contents up to USD 500,000.
- Limited take-up and highly concentrated geographically.
- Priced based on Flood Insurance Rate Maps (FIRMs) and specifications of the property, affordability is a policy concern.
- Relies on borrowing from U.S. treasury to pay claims and is deeply in debt.
- Started to purchase reinsurance in the private market in 2017.
- Two CAT bonds issued since 2018 to transfer USD 500 million and then USD 300 million to capital markets. Called for an additional USD 300 million in 2020.
- There is low demand.

Private sector flood insurance

- All peril policies for commercial and large companies.
- A small, growing residential market, targeting areas where insurance can be offered cheaper than that of the NFIP.
- There is low demand.

Other considerations for FRM

- Monitor, assess and provide ongoing feedback to improve the FRM system.
- Greater financial incentives for risk reduction are needed at all levels.
- Multi-stakeholder coordination platforms: some groups are attempting this, but initiatives are generally fragmented and small-scale.
- Educational, specialised and technical training programmes: there are local examples and examples in trade groups.
- Climate change needs to be consistently and comprehensively incorporated into all FRM policies.

Annex 2b: Flood risk management in the

	pre-1950s	1950s	1960s	1970s
Approach to managing flood risk	Dam and levee building	Permanent federal role in disaster aid established and authority vested with the President	Growing focus on land use	Recognition of moral hazard Expansion of federal role in mitigation National flood risk mapping program established
Major flood events			1965: Hurricane Betsy 1969: Hurricane Camille	1972: Tropical Storm Agnes
Major laws		**1950 Diaster Relief Act:** created Disaster Relief Fund **1953 Small Business Act:** provides disaster loans to households and small businesses	**1965 Water Resources Planning Act** **1968 National Flood Insurance Act:** Established federal flood insurance program	**1970 Disaster Relief Act:** aid for public buildings and temporary housing **1973 The Flood Disaster Protection Act:** mandatory purchase requirement added; aid limited if community doesn't participate **1974 Disaster Relief Act:** Hazard mitigation plans required, expanded assistance
Institutional changes and noteworthy developments	Rise of federal role	President assumes more control over disater aid **1958:** Gilbert White et al. bring changes in the urban occupance of floodplains	USGS and TVA undertake floodplain mapping Release of a Unified National Program for Managing Flood Losses Multiple states adopt floodplain development laws EO 11296 – requiring federal agencies to address flood risk	**1977:** Release of A Unified National Program for Floodplain Management Creation of Federal Interagency Floodplain Management Task Force EO 11988 – agencies do not support floodplain development **1979:** FEMA established by Executive Order

Source: The Geneva Association 2020a

United States: Pre-1950–2019

1980s	1990s	2000–2010	2011–Present
Establishment of current federal disaster aid approach	Rise of HUD's role in recovery Growing focus on enviromental benefits of wetlands	Katrina crises	Focus shifting to resilience Rise of technology for better risk communication Growing concern that climate change will worsen flooding
	1993: Midwest flooding	**2001: Tropical Storm Allison** **2004: Hurricane Ivan** **2005: Hurricane Katrina (Rita and Wilma)** **2008: Hurricane Ike**	**2011: Hurricane Irene** **2012: Hurricane Sandy** **2016: Louisiana flooding (Baton Rouge)** **2017: Hurricane Harvey (Irma and Maria)**
1982 Coastal Barrier Resources Act: no federal expenditures or flood insurance on certain barrier islands **1988 Stafford Act:** current aid structure: IA, PA and HMGP	**1993 Hazard Mitigation and Relocation Assistance Act**	**2006 Post Katrina Emergency Management Reform Act:** national disater recovery startegy and national disaster housing strategy	**2013 Sandy Recovery Improvement Act:** streamlined aid
1983: WYO program in the NFIP established **1983:** guidelines for USACE establish National Economic Development as objective **1986:** Unified National Program for Floodplain Management	FEMA establishes Community Rating System Growing use of floodplain buyouts **1993:** First use of CDBG for disatser recovery **1999:** ASFPM creates Certified Floodplain Manager program Galloway Report: focus on role of floodplain restoration	**2002:** DHS established, FEMA moved in **2004:** Longterm Community Recovery process created large supplemental spending for Katrina due to a perceived failure in response and collapse of levees	**2011:** National Disaster Recovery Framework - statement of natioanal recovery strategy, need for cross-scale coordination, empowers local governments **2012:** Hurricane Sandy Rebuilding Task Force Emergence of residential private flood insurance

Annex 3a: The flood risk management

Risk assessment and communication

- The EA is responsible for the delivery of flood risk maps & National Flood Risk Assessments (NaFRA).
- LLFAs identify flood areas, prepare hazard and risk maps and management strategies consistent with national strategy (maps focus on residential property and do not cover infrastructure, utilities and commercial assets).
- The insurance industry and Flood Re conduct regular assessments and have commercial models, often from private modelling firms, but there are some efforts to align the private and public sectors, particularly for incorporating flood defence information.
- Public flood risk maps can be accessed online and a variety of flood risk awareness games and art are offered by the insurance industry and government.
- The EA, Met Office, non-profit groups, insurers and academic institutes are involved in raising awareness.

Response and reconstruction

- Emergency planning and recovery efforts are governed by the Civil Contingencies Act 2004, which lists local authorities, the EA and emergency services as Category 1 responders to emergencies, and sets out their duties in case of a flood.
- Reconstruction involves another set of actors, including loss adjustors, assessors and builders, with funding from private market insurance, the Bellwin scheme (and grants from national government and local authorities).
- No requirements for 'building back better', but guidelines are currently in development (insurance industry, government, reconstruction sector).

Risk governance

National agencies

- The Department for Environment, Food and Rural Affairs (DEFRA) is responsible for flood protection and climate adaptation.
- The Ministry of Housing, Communities and Local Government (MHCLG, formerly Department for Communities and Local Government) oversees planning and building regulations.
- The Cabinet Office is responsible for civil protection and resilience.

Legislation

- The 2010 Flood and Water Management Act (FWMA) merely requires a national flood management strategy to be developed by the Environment Agency (EA).
- The Flood Risk Regulations (FRR) 2009 and the FWMA identify six actors that constitute English Risk Management Authorities (RMAs):
  - the EA
  - Lead Local Flood Authorities (LLFAs) (Unitary Authorities or County Councils)
  - Internal Drainage Boards (IDBs) (where in existence)
  - District and Borough Councils
  - the Highways Agency
  - Water Companies.
- The Civil Contingencies Act of 2004 is another important piece of legislation, which made it a requirement for most designated responders to carry out risk assessments at the national and local levels.

Risk prevention through planning and land use

- Effectiveness of the current planning system is unclear given pressure for new buildings and developments. Overall, continued building in high-risk zones.
- MHCLG sets planning policy through the National Planning Policy Framework and is responsible for its enforcement.
- Local governments have to apply a sequential test to steer development away from high- and medium-flood risk areas, which the EA can challenge.
- Regulations on planning and land use require Flood Risk Assessment reports for areas larger than one hectare in zones 1, 2 and 3.
- Effectiveness of these measures is not clear.

Source: The Geneva Association 2020b

system in England

Early warnings linked to emergency preparedness

- The National Flood Forecasting Centre (FFC) was launched as a partnership between the EA and U.K. Met Office.
- The EA introduced flood warning codes based on three levels, colour coding (amber to red) and symbols.
- The FFC produces alerts and warnings are disseminated via a variety of agencies.
- Broader 'emergency' civil protection policy as per the Civil Contingencies Act 2004 and DEFRA's National Flood Emergency Framework for England.
- The EA does a significant amount of awareness raising, including via Twitter.

Risk transfer

- Traditionally the approach to FRM has been risk-based rather than solidarity-driven, with a strong focus on insurance as the predominant way to finance losses.
- Very high insurance penetration for residential properties – coverage is part of the standard package – but exclusions can apply if high-risk.
- Flooding is covered under standard home insurance, banks require evidence for flood insurance for mortgage lending; SME flood cover is included under business insurance packages.
- Flood Re was introduced to deal with affordability and availability concerns. It is not risk-based, partly funded through private markets and voluntary. There are no incentives for risk reduction through premium discounts. Deductibles reflect risk levels and penetration rate is high; however, it assumes that until 2039, government, homeowners and other stakeholders will do their part to reduce flood risk, leading to no further public intervention in the flood insurance market.

Risk reduction

- The main focus is on flood defences, more recently also considering property-level protection and temporary defences. Measures range from large-scale regional to household level with different funding mechanisms, for example:
  - Regional, such as Thames Barrier
  - Local (funding administered by the EA and MHCLG)
  - Property-level flood resilience (PFR) and property-level protection measures (PLPMs) from national and local government (uptake remains low)
- Estimated GBP 1.1 billion/year in savings from risk reduction investments.

Risk financing for public assets

- When flooding occurs, by law, public authorities are only liable in cases of negligence. There is no right to compensation.
- Damage to public assets (such as council-owned buildings) may be funded in a variety of ways:
  - Local authorities take out insurance for their physical asset(s)
  - National budget reallocations (generally ad hoc)
  - Through central funds, such as the Bellwin scheme, or the agricultural flood recovery fund

Other considerations for FRM

- Monitor, assess and provide ongoing feedback
  - Usually carried out through post-disaster audits
  - Occasional reviews
  - Committee on Climate Change (CCC) conducts reviews
- Incentivise risk-based decisions
  - Not evident
  - Uptake of grants/funds for disaster reduction is low
  - No incentives provided through Flood Re
- Multi-stakeholder coordination platforms
  - Cross-sectoral collaboration between the government (centralised, decentralised) and the private sector
  - A number of approaches to multi-stakeholder funding and implementation
  - Insurance industry engagement in resilience roundtables
- Educational, specialised and technical training programmes
  - Local examples, academia and trade groups
- Climate change considerations
  - More recently a greater focus on future risks
  - The first full assessment of future flood risk was carried out under the Foresight Initiative
  - Climate change considerations are integrated into FRM and long-term planning by the EA
  - CCC regularly reviews FRM progress

Annex 3b: Flood risk management

	pre-1950s	1950s	1960s	1970s
Approach to managing flood risk	Focus on land drainage and civil defence			Shifting focus towards defence, increase in insurance coverage approach
Major flood events	**1952 Lynmouth Flood** **1953 East Coast floods, which resulted in 308 deaths**			
Major laws	**1949: Coast Protection Act**			
Institutional changes and noteworthy developments	**1930:** Catchment boards created **1948**: River boards created	**1953:** Storm Tide Forecasting Service (STFS) was established and operated by the Met Office	**1961**: Gentleman's Agreement. Efforts by the government to increase usage of flood insurance led to a commitment from the insurance industry to provide affordable insurance against flooding, if requested to do so, for all private dwellings which were permanently occupied **1963**: River Authorities created and made responsible for forecasting	The Building Societies Association make insurance coverage a prerequisite to obtaining mortgage financing, which leads to an increase in insurance penetration rates **1971:** Separation of emergency planning and civil defence **1975:** Regional Water Authorities created

Source: The Geneva Association 2020b

in England: Pre-1950–2019

	1980s	1990s	2000–2004
		Shift towards integrated coastal and fluvial flood risk management	Insurance industry calls for greater public investment Greater holistic/integrated emergency management and water approach Recognition of climate change impacts Discursive shift towards the success of local community partnerships The EA is empowered to plan for future flooding
	1982 floods: USD 700 million overall losses USD 300 million insured losses	**1998 floods: USD 460 million overall losses USD 230 million insured losses**	**2000: 10,000 homes in the U.K. flooded USD 2 billion overall losses USD 1.5 billion insured losses**
			2004: Civil Contingencies Act Regional Flood Defence Committee Order (Southern, Wessex & Anglian)
	1982: Thames Barrier **1980s:** Water privatisation and creation of water companies **1983:** Bellwin scheme. Local authority financial recovery **1985:** Devolution as emergency planning guidelines released for local authorities	**1996:** The EA is responsible for flood warnings and national warning strategy established	**2001:** ABI Memorandum states that ABI member companies would only maintain insurance provision if there was greater investment in flood risk reduction measures by the government **2002:** Statement of Principles on the Provision of Flood Insurance. Provided for flood coverage generally up to a risk level of 1:75 return period (1.3%) for households and small businesses as part of their building and/or contents cover **2002:** National Flood Forum established **2004:** Foresight Future Flooding Report (updated 2008). Report on how climate change will affect flooding in 30–100 years, aims to inform policy **2004:** Making Space for Water. Strategy for joining up plans for water in the future, taking the water cycle as a whole

Annex 3b: Flood risk management

	2005–2009	2010–2014
Approach to managing flood risk		
Major flood events	**2005 floods: USD 660 million overall losses USD 460 million insured losses** **2007 floods: USD 8 billion overall losses USD 6 billion insured losses** **2009 floods: USD 450 million overall losses USD 290 million insured losses**	**2013/2014 winter floods: USD 1.5 billion overall losses, USD 1.1 billion insured losses**
Major laws	**2005: The Civil Contingencies Act 2004** (Contingency Planning) Regulations **Regional Flood Defence Committee Order** (Yorkshire, Welsh, North West, Severn-Trent) **2009: Flood Risk Regulations** (implements EC directives) **2009: The Flood Defence** (Robertsbridge Works) Order	**2010: Flood and Water Management Act.** Granted the EA strategic overview of FRM and required it to develop a national strategy for flood and coastal risk management in England **2010: The Flood Risk Management Functions Order** **2010: The Flood Risk (Cross Border Areas) Regulations** **2010: Planning Policy Statement 25 Supplement:** Development and Coastal Change **2011: Localism Act** **2014: Water Act and Regulations**
Institutional changes and noteworthy developments	**2005: Updated Statement of Principles.** Continues the SoP commitment to 2008 **2008: Revised Statement of Principles on the Provision of Flood Insurance.** Continues the SoP commitment to 2013, but does not apply to any new property built after 1 January 2009 **2009: Flood Forecasting Centre** (operated jointly by the Met Office/EA) launched, which provides a comprehensive, 24/7 forecasting service. The EA provides flood warnings based on these forecasts. **2009: ABI guidance to assist developers** building flood resilient properties **2009: Investing for future flood and coastal risk management in England** **2008: Future Water.** Strategy on water as a resource and plans to 2030 for water supply demands	**2008: The Pitt Review.** Called for greater collaboration between various government departments, leading to the Flood and Water Management Act **2010: National Flood and Coastal Erosion Risk Management Strategy for England.** Strategy document on what the authorities can do to manage flood and coastal erosion risk and consequences **2011: Flood and Coastal Resilience Partnership Funding** **2011: The Regional Flood and Coastal Committees (England and Wales) Regulations** **2011: The Incidental Flooding and Coastal Erosion (England) Order 2011** **2011: The Thames Regional Flood Defence Committee (Amendment) Order** **2011: The Flood Risk Management Overview** and Scrutiny Committee (England) Regulations **2012: National Planning Policy Framework and Technical Guidance.** Advises on the development and consolidation of planning guidance and its implementation, specifically in areas of flood risk

Source: The Geneva Association 2020b

in England: Pre-1950–2019

	2015–2017	2019
	Renewed focus on climate change and better climate forecasting. Support for reinsurance and collaboration between public, insurance and non-profit sectors	An overall shift to a more resilience-based approach, recognising climate change; insurance not used for risk reduction or resilience incentives
	2015/2016 winter floods: USD 2.4 billion overall losses USD 1.64 billion insured losses	**Two flood events: USD 188.81 million overall losses USD 142.93 million insured losses**
	2015: The Flood Reinsurance (Scheme Funding and Administration) Regulations **2017: The Water Environment (Water Framework Directive) (England and Wales) Regulations**	**The Flood and Water (Amendments) (England and Wales) (EU Exit) Regulations**
	2015: Committee on Climate Change. Research suggests that the rate of residential development is increasing in floodplain areas and is higher than in other areas. The government has adopted a policy of providing automatic planning permission on brownfield sites **2016: Property Resilience Grant Scheme launched.** Operated by the national government and administered at the district level, it provides grants of up to GBP 5,000 for the adoption of property-level protection measures **2016: National Flood Resilience Review.** Highlights the need to protect key local infrastructure more effectively, improve incidence response and to continue improving risk communication by the EA **2016: Flood Re launched**. A non-profit reinsurance pool owned and operated by the insurance industry, developed by industry and government, intended as a transitional measure to make way for risk-reflective pricing by 2039. Flood Re gives insurers the option of reinsuring high-risk policies at a subsidised price; the logic being that insurers can pass on their own cost savings to policyholders, making flood insurance more affordable, even for those at high risk	**The EA consults on national resilience strategy** **Committee on Climate Change publishes UK Climate Risk Assessment:** identified flooding as the biggest challenge to the country, warns of insurability and affordability concerns **Flood Re publishes Transition Report:** highlights commitment to resilience **Resilience Repair guidance from DEFRA Resilience Roundtable published**

Annex 4a: The flood risk management

Risk assessment and communication

- Several activities across the country and within individual states (Länder) are underway, involving different actors, such as the Federal Institute of Hydrology (BfG) and the German Weather Service (DWD).
- The German Insurance Association (GDV) and insurers have developed a countrywide flood hazard zoning system: ZÜRS (not accessible to the general public).
- There are several initiatives and activities to assess risks with cities, local authorities, non-profit groups, academic institutes and private risk modelling firms. There are limited efforts to integrate different maps, datasets or models.

Response and reconstruction

- While large-scale government aid and insurance payouts have led to relatively quick reconstruction and recovery after recent flood events in Germany, in 2002 and 2013 the opportunity to combine reconstruction with risk reduction was largely missed.
- Limited evidence of 'building back better'.

Risk governance

- Each level of government has few absolute duties:
  - Federal (Bund): sets general standards
  - State (Länder): responsible for all water issues, civil protection and actual risk management on the ground; manages fluvial and coastal flood risk
  - Municipal/local: manages pluvial flood risk
- FRM is coordinated through various inter-governmental mechanisms such as the joint Bund-Länder working group on water (LAWA).
- Multi-level governance can result in different management approaches across institutions and government levels.
- Legislative action has been triggered by major floods.
- EU Floods Directive sets out an overarching framework.

Risk financing for public assets

- Germany is firmly committed to risk-based compensation through private insurance. This long-standing policy commitment is reinforced by individual 'duty of care' to mitigate flood damages. Local authorities increasingly take out insurance for their physical assets.
- In most of the federal states, the government has little or no legal obligation to compensate damages to homeowners and businesses, which are funded through 'insurance or the accumulation of reserves'.
- In case of financial hardship, governments still provide payouts as part of the German social welfare system.

Source: The Geneva Association 2020c

system in Germany

Early warnings linked to emergency preparedness

- The DWD is leading efforts to develop and issue weather warnings and flood warnings.
- Civil protection and emergency management services are managed at the state level.
- Flood warnings and civil protection can differ throughout the country.
- The Federal Office of Civil Protection and Disaster Assistance (BBK) undertakes risk analysis for civil protection from different hazards and publishes them in a parliamentary report.

Risk transfer

- Flood insurance coverage is voluntary, provided by the private market as supplementary cover to standard policies.
- Penetration rates differ across regions for historic reasons.
- Following information campaigns and changes to state compensation, penetration rates have increased, currently sitting at 41%.
- The insurance industry and government partner to provide risk information and increase awareness (Kompass Naturgefahren, formerly ZÜRS public).

Risk reduction

- Law does not state 'individual entitlement to flood protection'.
- According to the 2009 update of the Federal Water Act, 'every person who may be affected by floods is, as far as possible and reasonable, obliged to take appropriate precautionary measures'.
- Responsibility for flood protection lies with the 16 federal states, leading to different levels of flood protection.
- According to the Federal Water Act of 2009, property owners are responsible for protecting their properties, for example through the implementation of property-level mitigation measures (PLPMs).
- The uptake of PLPMs by property owners is growing.
- 'Flood passport' initiative (Hochwasserpass) will recognise property-level risk and resilience.

Risk prevention through planning and land use

- Before the 2002 floods, there was very limited recognition of flood risk in development planning and land zoning practices.
- This changed in 2005 with the introduction of the Flood Control Act. The effectiveness of these measures is not clear.
- The second Omnibus Flood Control Act 2018 introduced stricter building codes in 100-year flood zones and new regulations for the use of flood-prone areas outside statutory inundation areas.

Other considerations for FRM

- Monitor, assess and provide ongoing feedback.

  Currently

  - Tracking and monitoring FRM performance tends to be conducted in the form of post-event assessments.
  - Several post-flood reviews have been undertaken by the German Committee for Disaster Reduction (DKKV). These have uncovered strengths and weaknesses but there is no formal monitoring of improvements.
- Incentivise risk-based decisions.
- Multi-stakeholder coordination platforms.

Cross-governmental collaboration
to address

- Urban pluvial floods.
- EU directives.
- Cross-border challenges along river basins due to different community interests.

Cross-sectoral collaboration

- Partnership between the insurance industry and government to provide risk information and increase awareness.
- Educational, specialised and technical training programmes.
  - Currently some programmes are carried out by academia and trade groups.
- Climate change considerations.
  - While climate change is increasingly recognised as a key risk factor, there appears to be a lack of strategic focus on how to achieve future flood resilience. In this regard, engagement of the expert community with FRM and adaptation appears limited, at least at the federal and state levels.
  - Local communities and cities are more advanced, having accounted for expected increases in heavy precipitation events in spatial planning decisions and in updating drainage and sewer systems.

Annex 4b: Flood risk management in

	pre-1950s	1950s	1960s	1970s	1980s
Approach to managing flood risk	Encroachment, rectification and canalisation Building of large dams to regulate discharge	Technocratic safety approach with strong focus on structural flood protection Focus on water infrastructure to support economic reconstruction 10–20% of natural flood plains remained by the 1970s Peak in water pollution in river systems reached by the late 1970s			Renaturalisation Natural safety
Major flood events	**1947: Oder flood**		**1962: North Sea flood**		**1981: Weser flood**
Major laws			**1960: Federal Water Act (Wasserhaushalts-gesetz).** Framework legislation giving responsibility to federal states in managing floods		**1988: Integrated Rhine Program.** Combining natural development and flood protection
Institutional changes and noteworthy developments	Redrawing of national borders in Europe including major river basins such as Rhine and Oder after WWI and WWII	Establishment of federal regime with decentralised flood management resting in the individual federal states Foundation of national and international working groups to coordinate decentralised flood risk management (LAWA and ICPR)	Devastating 1962 flood initiated major improvements in flood protection along the German coast German army was deployed in Hamburg for emergency purposes, violating the German constitution prohibiting using the army for internal affairs A clause that excluded disasters was added in 1968		Germany and France sign a treaty for a joint flood plain restoration programme along the Rhine river

Source: The Geneva Association 2020c

Germany: Pre-1950–2019

1990s	2000–2004	2005–2008
Shift from pure technically-oriented flood protection towards a more integrated FRM approach as laid out by LAWA (1995)		
1993 floods: USD 620 million overall losses, USD 186 million insured losses **1994 floods: USD 770 million overall losses, USD 258 million insured losses** **1995 floods: USD 399 million overall losses, USD 144 million insured losses** **1997: USD 382 million overall losses, USD 38 million insured losses**	**2002 floods: USD 11.83 billion overall losses, USD 1.87 billion insured losses**	
1999: Three pillars of modern flood management (Environmental Minister Conference)	**2002: Disaster Relief Act** EUR 7.1 billion	**2005: Omnibus Flood Control Act**. Included the preparation of flood management plans per catchment and stricter regulations for built-up areas in flood-prone areas came into effect. In addition, private precautionary action was requested from every person living in a floodplain in accordance with their resources and capabilities
German reunification Federal state of Baden Württemberg abandons compulsory state-provided flood insurance (as part of home insurance) due to EU anti-monopolisation laws New federal states in the former GDR do not include flood insurance under household insurance	**2002: Government Review**. Von Kirchbach et al. (2002) **2003: 5-Punkte-Programme.** Five-point action programme on how to improve flood risk management was agreed upon and paved the way for amendments in related legislation **2003: Flood Review DKKV**. Revealed major deficiencies in Germany's flood risk warning and communication (DKKV, 2003) **2004: State-level programmes.** The Free State of Saxony, the most severely hit state in 2002, planned 1,600 measures **2001: ZÜRS** (fourth zone introduced 2003). Zoning system used to assess the insurability of properties **2002: Negotiations about compulsory flood insurance** **2004: German industrial standard.** Introduction of DIN 19700 for the assessment of the risks of dam failures	**2005–2007: Research programme RIMAX** **2007: EU Floods Directive.** Flood-adapted spatial planning has received a considerable boost through the European Floods Directive (2007/60/EC) as well as through changes in the Federal Water Act in 2005 and 2009 (Thieken et al. 2016).

Annex 4b: Flood risk management in

	2009–2012	2013–2015
Approach to managing flood risk	Shift from condition-based governance to performance-based policy regulations that define targets and thus offer a broader scope of implementation	
Major flood events	**2010 floods: USD 1.31 billion overall losses USD 400 million insured losses (river dykes burst, dam failed)**	**2013 floods: USD 10.4 billion overall losses USD 2.2 billion insured losses** **2014 floods: USD 600 million overall losses USD 270 million insured losses**
Major laws	**2009: Revision of the Federal Water Act.** Resulted in a shift from condition-based governance with precise 'if..., then...' rules to performance-based policy regulations that define targets and thus offer a broader scope of implementation	**2013: Disaster Relief Act (EUR 8 billion)**
Institutional changes and noteworthy developments	**2010: New standard insurance conditions** (opt-out option for natural hazards supplement), adaptation success. Smaller flood events in 2005, 2006, 2010 and 2011 already revealed that regional and local governments as well as flood-prone residents and companies had adapted to flood risk and had implemented precautionary and preparatory measures (Kreibich et al. 2011a, Kienzler et al. 2015a, Thieken et al. 2016) **2011: An additional open-access multihazard web portal Kompass Naturgefahren** launched by the GDV for pilot regions. Seen as a prototype for a web-based hazard and risk information platform for the whole country, the web portal was decided on in October 2014 by the Conference of Ministries of the Environment (UMK) **2011: Loss compensation guidelines (BY; SN). Information campaigns on flood insurance** (since 2009). (Together with upper water authorities). The campaigns mainly inform about the availability, costs and advantages of flood insurance in Germany	**2013: New negotiations about compulsory flood insurance** (ended June 2015, no compulsion) **2013: A modular warning system (MoWaS)** that states and communities could tap into triggers certain so-called 'warning multipliers' via mass media, internet portals, and the federal emergency information app (Notfall-Informations- und Nachrichten-App des Bundes, NINA) **2014–2015: National Flood Protection Programme (EUR 5.44 billion).** A joint effort between the federal government and all federal states, covering around 100 measures with investments of more than EUR 5.4 billion (DKKV 2015) **2014: Updated flood maps released**. This resulted in a reduction in the share of homes assigned to high-risk areas from 1.5% of all buildings in 2008 to 0.65% of all buildings in 2016 (GDV 2016) **2014: Hochwasserpass (building certficate) introduced.** Joint initiative of the GDV and civil and water engineers **2015: Statutory rules** that aim to prevent surface sealing in these areas are part of the Saxon Water Act (SächsWG §76 as of 2015)

Source: The Geneva Association 2020c

Germany: Pre-1950–2019

2016	2017
USD 2.87 billion overall losses **USD 1.34 billion insured losses** **Surface water/pluvial flood in Berlin with estimated EUR 60 million damage** **Flash floods in southern Germany**	**USD 318 million overall losses** **USD 70 million insured losses**
	Omnibus Flood Control Act II (Hochwasserschutzgesetz) 2017/2018. Regulations for the use of flood-prone areas outside statutory inundation areas, for example, requirements for flood-adapted building design and flood-secured oil tanks. In recent flood events, floating oil tanks were identified as an important damage driver, particularly in areas that had been inundated due to dike breaches (DKKV 2015). In 2017, legal instruments to prevent increases in damage potential behind dikes or other structural flood defenses were established in the second Flood Control Act
The DWD planned to map flash flood hazard zones and improve local warnings **Zurich published recommendations on flash floods and risk reduction** (Zurich PERC) **LAWA decided to provide a centralised web-mapping service** for flood hazard and flood risk maps for Germany (Nationale HWGK/HWRK) **The Bavarian Environment Agency commissioned the project HiOS (Hinweiskarte Oberflächenabfluss und Sturzflut):** After the severe flash floods in Simbach am Inn in Bavaria in 2016, this was launched to develop and test a procedure for the evaluation and classification of the risk to Bavarian municipalities from surface runoff and flash floods	

	2018	2019
Approach to managing flood risk		
Major flood events	USD 10 million overall losses USD 0 insured losses	USD 15 million overall losses USD 3 million insured losses
Major laws		
Institutional changes and noteworthy developments	**LAWA published recommendations** for minimum standards of flood hazard and flood risk maps to produce consistent maps for all federal states to comply with the EU Floods directive **LAWA published its first strategy report** for effective management of surface water flooding. LAWA calls on local communities to investigate the communal risk of surface water flooding and to develop local mangement plans, including information for the public **The GDV launched its Stadt.Land.unter campaign** and release a German-wide heavy rainfall map in cooperation with the DWD. The campaign aims to inform the general public about the risks from heavy rainfall and surface water flooding	**State of Bavaria decided to no longer pay disaster support** for flood risk victims starting July 2019, urging homeowners and businesses to take out insurance **The DWD and GDV completed their four year research project on heavy rainfall**, surface water flooding and damage. The project created three surface water flood hazard zones for the whole of Germany, which are now implemented in ZURS Geo, the main risk assessment tool of the German insurance industry. According to these maps, 11.8% of properties in Germany are located in the highest hazard zone. Based on the methods developed in the project the DWD now issues an annual extreme rainfall report. The project also included three pilot cities which should directly benefit through improved knowledge of their surface water FRM

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As the world deals with the COVID-19 pandemic crisis, the potential compounding effects of weather-related extreme events, such as floods, tropical cyclones and wildfires, could significantly challenge a country's emergency management capacities and slow down its socio-economic recovery. Floods are among the most concerning and costly weather-related events globally. This study analyses the evolution of flood risk management (FRM) in the United States, England and Germany and provides lessons and recommendations based on identified trends and patterns, pointing to the need for a paradigm shift from reacting to crises to taking a risk-based, anticipatory and holistic approach to managing the potential impacts of catastrophes.

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