



OECD Conference on the Financial Management of Flood Risk

Building financial resilience in a changing climate

PROGRAMME

**12-13 May 2016
Paris, France**

About this conference

Flooding is one of the most common, wide-reaching and destructive natural perils, affecting tens of millions of people around the world each year and causing, on average, more than USD 40 billion in damages. The financial management of flood risk presents a significant policy challenge in many countries, requiring careful consideration of the relative effectiveness of various tools to manage flood risk, from investments in risk prevention and public awareness, to the use of risk transfer tools to protect against significant post-disaster costs. This conference will provide an opportunity to exchange knowledge and share experiences on effective approaches to the financial management of flood risk.

The organisation of this event is being supported by a financial contribution from Zurich Insurance Group, which has launched a global flood resilience program to contribute with its risk expertise as a global insurer to help customers and communities to reduce the devastating impact of floods (see: www.zurich.com/en/corporate-responsibility/flood-resilience).

About the OECD

The OECD plays a leadership role in supporting the development of strategies for the financial management of natural and man-made disaster risks and has provided guidance and analysis on these issues for the G20 and APEC Finance Ministers. This work is undertaken under the guidance of the High-Level Advisory Board on the Financial Management of Large-scale Catastrophes and the Insurance and Private Pensions Committee. The OECD provides a unique forum for governments to compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

PROGRAMME

12 May 2016

08:30-09:00 *Registration of participants*

09:00-09:30 **Opening Session**

Chair **Erwann Michel-Kerjan**, Executive Director, Wharton Risk Management and Decision Processes Center and Chair, OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes

Speakers **Rintaro Tamaki**, Deputy Secretary General, OECD, *Opening address*
Saad Mered, Global Chief Claims Officer, General Insurance, Zurich Insurance Company, *Special address*
Alice Hill, Special Assistant to the President and Senior Director for Resilience Policy, National Security Council, White House, *Special address*

09:30-11:15 **Session 1: The evolving nature of flood risk – understanding flood drivers and impacts**

Topics Flooding is one of the most common, wide-reaching and destructive natural perils, affecting on average approximately 250 million people around the world each year. In many countries, significant portions of the population now live in areas prone to flooding, including in a number of fast-growing mega-cities. There are a number of causes and types of flooding, including flash floods, riverine floods, urban floods, groundwater floods and coastal floods (including sea surge) – each creating different types of risks and different challenges in terms of risk assessment. This session will provide an overview of the different types of floods and their meteorological/hydrological drivers, potential changes in the nature of flood risk as a result of climate change and technological advancements that are improving the quantification of flood risk.

Moderator **Robert Muir-Wood**, Chief Research Officer, Risk Management Solutions and Vice-Chair, OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes

Panellists **Wolfgang Kron**, Head of Research for Hydrological Hazards, Munich Re
Zbigniew Kundzewicz, Head of Climate and Water Department, Institute of Agricultural and Forest Environment, Polish Academy of Sciences and Senior Scientist, Potsdam Institute for Climate Impact Research
Dominique Bérod, Senior Expert - Water, Disasters and Cold Regions, Group on Earth Observations and Hydrological adviser to the World Meteorological Organisation
Milan Simic, Executive Vice President, Managing Director of International Operations, AIR Worldwide

11:15-11:30 *Coffee break*

11:30-13:00

Session 2: Flood risk – a public financial management challenge

Topics

The financial management of flood risk requires a holistic approach that considers the potential contributions of prevention, preparedness and financial protection. This requires careful consideration of the relative efficiency and effectiveness of public investments in structural and non-structural flood mitigation, early warning and emergency preparedness and support for financial protection against both private and public flood losses. This session will explore the approaches taken to this public financial management challenge by countries facing very different levels of flood risks and flood insurance market development with the aim of identifying lessons learned from country experience in the overall financial management of this risk.

Moderator

Alberto Monti, Full Professor of Comparative Law, Institute for Advanced Study IUSS Pavia

Panellists

Inge Lardinois, Deputy Director, Directorate for Water Management, Directorate-General for Spatial Development and Water Affairs, Ministry of Infrastructure and the Environment, Netherlands

Kenzo Hiroki, Vice President, College of Land, Infrastructure, Transport and Tourism (CLITT), Ministry of Land, Infrastructure, Transport and Tourism, Japan and coordinator of the High-Level Experts and Leaders Panel on Water and Disaster

Jonathan Coppel, Commissioner, Australia Productivity Commission

Moritz Kraemer, Global Chief Rating Officer (Sovereign Ratings), S&P Global Ratings

13:00-14:30

Lunch break

14:30-16:30

Session 3: Building financial resilience against flood risk in developing countries (co-organised with the World Bank)

Topics

Developing countries are particularly at risk from flood. Rapid urbanization and asset concentration, combined with global climate change, are expected to generate increasing disaster losses going forward and further divert limited resources away from providing public services and new projects that build the foundation for growth. These economic impacts from floods are also increasingly spread to other countries, as demonstrated by the record floods that inundated large swaths of Thailand in the fall of 2011 and disrupted just-in-time production in many sectors around the world. However, the cost of disasters does not have to be so devastating. An increasing number of developing countries are implementing financial protection strategies against climate and disaster risks in order to secure financing for post-disaster rapid response and long term reconstruction. This session will reflect on the unique experiences of developing and emerging countries, and what lessons they can exchange with OECD countries.

Moderator

Olivier Mahul, Global Lead Disaster Risk Finance, World Bank Group

Panellists

Andrés Ricardo Quevedo Caro, Head of Risk Management, Ministry of Finance, Colombia

Daw Ni Ni Than, Director, Treasury Department, Ministry of Finance, Myanmar

Marko Blagojevic, Director, Public Investment Management Office, Serbia

Bui Thanh Hai, Deputy Director, Non-life Insurance Supervision Division, Insurance Supervisory Authority, Ministry of Finance, Vietnam

16:30-16:45

Coffee break

16:45-18:15 Session 4: Managing flood risk at the city-level

Topics

Cities are particularly vulnerable to flood risk given the concentration of assets, the tendency for cities to be located close to water and the negative impacts of built-up areas on groundwater absorption. In most countries, cities also have jurisdiction over many of the measures that can improve flood resilience, such as land-use planning, protective structures and the flood resilience of local public infrastructure. This session will explore the experience of cities in managing flood risk.

Moderator

Cristiana Fragola, Regional Director (Europe and the Middle East), Rockefeller 100 Resilient Cities

Panellists

Charles Baubion, Policy Analyst, Public Governance Directorate, OECD

Jeff Hebert, Chief Resilience Officer, City of New Orleans

Mia Ebeltoft, Deputy Director (Non Life), Finance Norway

Ivo Menzinger, Client Executive and Managing Director, Global Partnerships, Swiss Re

Erwann Michel-Kerjan, Executive Director, Wharton Risk Management and Decision Processes Center and Chair, OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes

18:15-20:00

Cocktail reception – OECD Conference Centre

13 May 2016

09:00-11:00 Session 5: Protecting households against flood risk – comparing the different approaches across OECD countries

Topics

There are various approaches to providing financial protection against the private flood losses of homeowners, including through private insurance markets, public-private partnerships and ex-post public compensation for losses. Each of these approaches have their costs and benefits and can create (dis)incentives for risk reducing behaviour. A common challenge to all these approaches is balancing affordability and availability of cover. The most effective approach depends on the level of flood risk, the depth and capacity of private insurance markets as well as cultural factors such as support for solidarity across segments of the population. This session will explore the approaches taken to providing financial protection by countries with varying levels of flood risk, flood insurance market development and appetite for solidarity.

Moderator

Swenja Surminski, Senior Research Fellow, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science

Panellists

Roy Wright, Deputy Associate Administrator for Insurance and Mitigation, Federal Emergency Management Agency, United States

Alfonso Nájera Ibáñez, Sub-Director for Studies and International Relations, Consorcio de compensación de seguros, Spain

Laurent Montador, Deputy Chief Executive Officer, Caisse centrale de réassurance, France

Aidan Kerr, Operations Director, Flood Re
Robert Whelan, Executive Director and CEO, Insurance Council of Australia
Anton Matzinger, Deputy Director General - Budget, DG Budget and Public Finances,
Federal Ministry of Finance, Austria

11:00-11:15

Coffee break

11:15-13:00

Session 6: Supporting insurability and affordability – challenges and innovations

Topics

One of the key challenges to the economic viability of flood insurance is establishing actuarially-sound premiums that are within the willingness-to-pay of large segments of the population, including both those at low risk of flooding and those facing significant and/or frequent flood loss events. A number of measures, including enhancing risk awareness and communications, investing in mitigation and providing premium subsidies, have the potential to support the economic viability of private insurance coverage of flood risk. This session will explore different approaches to enhancing the economic viability of insurance coverage for flood risk, based on the experience of a number of countries, as well as the relative effectiveness of these different approaches.

Moderator

Howard Kunreuther, James G. Dinan Professor of Decision Sciences & Public Policy and Co-Director, Wharton Risk Management and Decision Processes Center

Pannelists

Annegret Thielen, Professor for Geography and Natural Risks Research, University of Potsdam and Chair of Scientific Board of the German Committee for Disaster Risk Reduction (DKKV)

Don Forgeron, President & CEO, Insurance Bureau of Canada

Donald Griffin, Vice President, Personal Lines, Property Casualty Insurers Association of America

Thomas Luder, Senior Insurance Regulatory Expert, State Secretariat of International Finance, Federal Department of Finance, Switzerland

Sean Kevelighan, Group Head of Public Affairs, Zurich Insurance Company

13:00-13:15

Closing remarks

Speakers

Erwann Michel-Kerjan, Executive Director, Wharton Risk Management and Decision Processes Center and Chair, OECD High-Level Advisory Board on the Financial Management of Large-Scale Catastrophes

Timothy Bishop, Head of Division (Financial Affairs), Directorate for Financial and Enterprise Affairs, OECD



The organisation of this event is being supported by a financial contribution from Zurich Insurance Group.

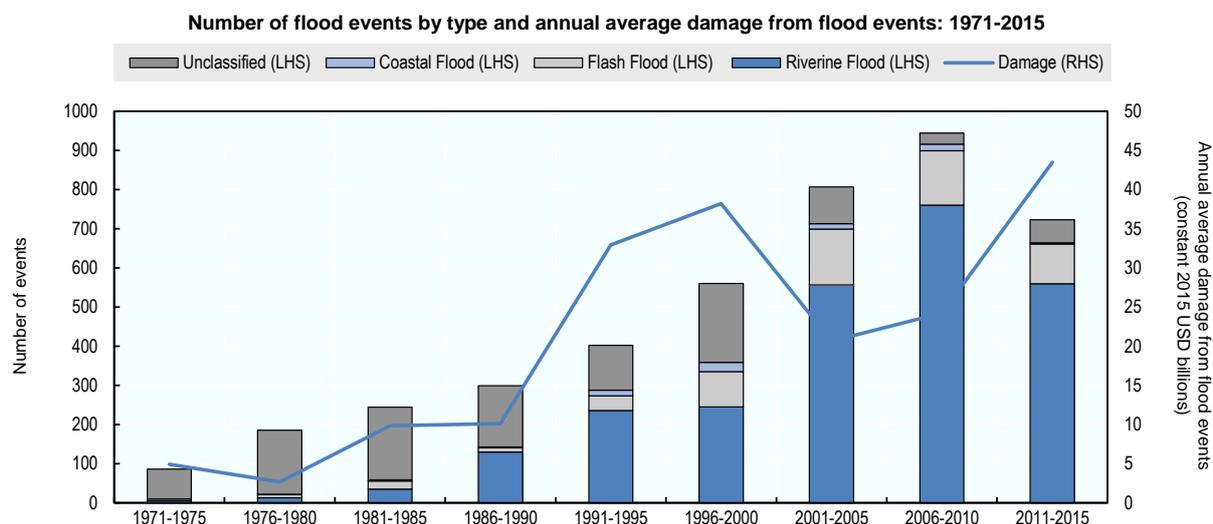
Notes

SESSION NOTES

Session 1: The evolving nature of flood risk – understanding flood drivers and impacts

Flooding is one of the most common, wide-reaching and destructive natural perils, affecting, on average, approximately 250 million people around the world each year (UNISDR, 2013) and causing USD 40 billion in losses on an annual basis. In many countries, substantial portions of the population now live in areas prone to flooding and floods have accounted for the most significant part of disaster losses and damages.

Population growth and the accumulation of assets in flood-prone areas have led to a substantial increase in built-up areas susceptible to flooding and therefore the size of the impacts arising from flood disasters. The number of people exposed to floods is expected to grow at a higher rate than general population growth (Keating et al, 2014). Increasing urbanisation will exacerbate this trend as, in urban areas, the capacity for rainfall absorption deteriorates and water runoff increases significantly above what would be expected to occur on natural terrain.



Source: EM-DAT. The US Bureau of Labor Statistics' *Historical Consumer Price Index for All Urban Consumers (CPI-U)* was used to convert data on damages to constant 2015 USD. Average annual damage is presented for each 5-year period. The number of events is presented as the total number of events during each 5-year period

Many of the largest flood events in terms of overall losses have occurred since 1990. Historically, reported losses from floods unrelated to cyclones are much smaller than losses from other types of natural disasters. However, losses from some major floods in recent years (such as the 2011 floods in Thailand) have reached levels more commonly associated with earthquakes and cyclones (which involve damage from both strong winds and water penetration). Direct losses from floods are increasingly significant for many countries. According to the EM-DAT data, since 1990, 36 countries have faced at least one year of damages to property, crops and livestock of USD 1 billion (in constant 2015 USD) or more from floods while 15 countries experienced at least one year of flood damages exceeding USD 5 billion.

Largest flood events (including cyclone-related flooding) since 2000 (constant 2015 USD billion)

Event	Estimated overall losses due to flood
Hurricane Katrina (US Gulf Coast) – 2005	100.7***
Hurricane Sandy (US Northeast) – 2012	47.5***
Chao Phraya (Thailand) – 2011	45.3
Elbe/Danube (Central and Southern Europe) – 2002	21.7
Hurricane Ike (Caribbean, US) – 2008	14.3*
Elbe/Danube (Central Europe) – 2013	12.8
Southern Alps (Italy and Switzerland) – 2000	11.7
Midwest/Missouri (US) – 2008	11.0
Indus (Pakistan) – 2010	10.3
Centre, South, East, Northwest (China) – 2003	10.2
Hurricane Ivan (Caribbean, US) – 2004	10.0*
Southwest, Centre, Northwest (China) – 2004	9.8
East, Southeast, South (China) – 2010	8.7
Hurricane Wilma (Caribbean, Mexico, US) – 2005	8.5*
East, Northeast, Southeast (China) – 2012	8.3
Tropical Storm Allison (Houston, US) – 2001	8.0
South, Southwest, East, Centre (China) – 2007	7.8
Monsoon rains (Bangladesh, India, Nepal) – 2004	6.3
Monsoon flash flood (Mumbai, India) – 2005	6.1
West (Calgary, Canada) – 2013	5.8
Hurricane Irene (Northeast, US) – 2011	5.3**
Typhoon Haiyan (Philippines) – 2013	5.1**

Source: The list of events, including estimates of overall losses at original value and the share of overall damage due to flooding, are taken from Kron (2015) using data from Munich Re's NATCATSERVICE. The US Bureau of Labor Statistics' *Historical Consumer Price Index for All Urban Consumers (CPI-U)* was used to convert data on damages to constant 2015 USD. * Indicates that the estimate was based on attributing one third of the overall damages to flooding. ** Indicates that the estimate was based on attributing one half of the overall damages to flooding. *** Indicates that the estimate was based on attributing two thirds of the overall damages to flooding.

While the evidence is far from conclusive, climate change is expected to impact the nature of flood risk going forward. The Inter-Governmental Panel on Climate Change (IPCC,2012) found evidence of a number of likely impacts of climate change on the nature of flood events (subject to significant regional variation and various levels of uncertainty), including:

- the frequency of heavy precipitation or the proportion of total rainfall from heavy rainfalls will likely increase over many areas of the globe as higher air temperatures allow the atmosphere to retain more water;
- the average tropical cyclone maximum wind speed will likely increase in some ocean basins;
- there may be a projected poleward shift of extratropical storm tracks;
- the mean sea level rise will very likely contribute to upward trends in extreme coastal high water levels; and
- changes in heat waves, glacial retreat, and/or permafrost degradation will affect high mountain phenomena such as slope instabilities, movements of mass, and glacial lake outburst floods.

The coverage of flood hazard maps and models has improved significantly in recent years although a number of important gaps remain. Floods pose a number of particular modelling challenges in terms of the scope of hazard modelling required (given the numerous potential causes of flooding), the impact on assets-at-risk (given the need for detailed data on land-use, elevation, etc.) and possible changes in the probability of occurrence (given the uncertain consequences of climate change) - with important implications for the analysis of risk reduction investments and the underwriting of financial protection. While advancements in technology (such as the increased granularity and coverage of satellite data) and improvements in the relevant science have improved the overall assessment of flood risk, the level of uncertainty remains significant.

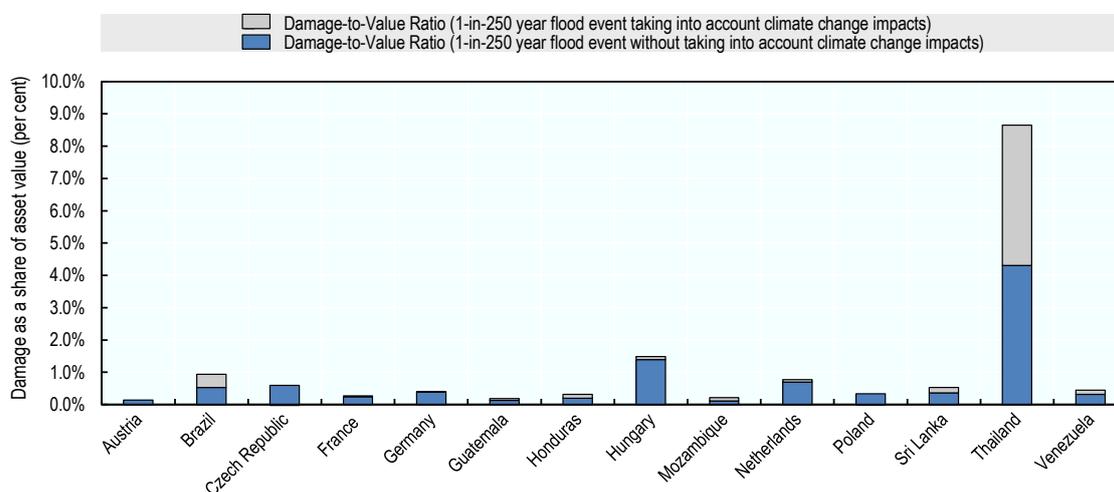
Key questions for discussion

- What are the forms of flooding and their meteorological and hydrological drivers? Are some types of flooding more destructive than others? What has been the evolution in exposures and losses?
- How will climate change impact the various types of flooding? Will some types of flood risk increase more than others?
- How is flood risk assessed and modelled? Are scientific and technological developments, such as increasingly granular satellite imagery, fundamentally advancing the capacity to assess flood risk?

Session 2: Flood risk – a public financial management challenge

In flood-prone countries, governments (local, regional and national) face significant costs related to the financial management of flood risk, including both the costs of investing in *ex ante* risk reduction as well as *ex post* costs related to emergency response, reconstruction of public assets, and compensation and financial assistance to sub-national governments, businesses and individuals affected by floods. For some countries, particularly developing countries, the impact of a large flood event could have a significant impact on public finances and even on sovereign credit ratings as a result of a reduction in economic growth, increases in public spending on reconstruction and a deterioration in export performance. An analysis by Standard and Poor's Rating Services (2015) (and Swiss Re) of the damage (as a share of asset values) from a 1-in-250 year flood event found that, in some countries, a major flood could have a material impact on sovereign credit ratings, particularly when taking climate change impacts into account.

Damage-to-value ratio from a 1-in-250 year flood: impact of climate change



Source: Standard and Poor's Ratings Services (2015)

The effective financial management of these fiscal costs requires governments to: (i) assess the potential exposures that they face, based on a range of potential flood scenarios, both normal and more extreme; and (ii) evaluate the most effective way to manage these exposures, considering the potential roles of investments in risk reduction, risk transfer and *ex post* response.

A comprehensive assessment of flood exposure is a prerequisite for evaluating the relative costs and benefits of investments in risk reduction measures. However, a number of challenges remain in terms of the availability of data necessary to quantify exposure to flood risk. There are significant gaps in the availability of high-quality flood risk maps in many countries and very few countries are covered by probabilistic catastrophe models developed by the private sector. The uncertain impact of a changing climate on flood risk exacerbates this challenge and requires consideration of climate change allowances in assessments of flood risk and/or the use of more severe climate change scenarios. Some governments have begun to account for climate change in their flood assessments, for example, the Netherlands Delta Committee, tasked with providing advice on long-term flood protection in the context of climate change, considered high-end climate scenarios out to 2200 in its assessment. The Thames Estuary 2100 study also used a "high-plus-plus" climate scenario in its assessment of options for providing flood protection for London out to 2100 (Wilby and Keenan, 2012). In Germany, the landers of Bavaria and Baden-Württemberg have introduced a "climate surcharge" into the design of all flood-related structures (i.e. the (calculated) design flood discharge value (projected flood) is augmented by 15 % to account for climate change).

The effective management of flood risk requires consideration of the combined contributions of land-use planning, large-scale structural mitigation, household risk reduction measures and insurance and financial assistance arrangements as well as the incentives created by these different approaches and the impact of those incentives on ultimate costs. For example, the broad availability of *ex post* public compensation may reduce the incentives for

households and sub-national governments to invest in risk reduction or risk transfer and may ultimately increase the eventual costs of financial assistance and compensation provided. High standards of physical or financial protection might create inappropriate incentives for developing flood-prone areas. The cost of a government reinsurance or guarantee arrangement to support insurance coverage needs to be weighed against the expected reduction in *ex post* compensation needs post-event as well as any benefits of insurance (relative to *ex post* compensation) in terms of the incentives created for risk reduction.

A reliance on *ex post* financing of disaster costs may also lead to a bias against *ex ante* mitigation (Productivity Commission, 2014). In many countries, the design of insurance and compensation arrangements (e.g. lack of risk sensitivity), the governance arrangements related to public expenditure (e.g. the political advantages in providing financial assistance) as well as the tendency to underestimate (or underweight) the significance of flood risk have led to general under-investment in disaster prevention and risk reduction at the household, community and/or national-level. In many countries, significantly more funds are allocated to disaster response than risk reduction. For example, in the past two decades, approximately 87% of the estimated USD 107 billion provided as development assistance for disaster-related costs was devoted to post-disaster response and reconstruction, and only 13% was devoted to risk reduction and other *ex ante* risk management measures (Keating et al., 2014). This is despite the significant benefits that investments in prevention can provide in terms of avoided losses. For example, in the United Kingdom, the Environment Agency (2014) estimates that its capital investment in the flood and coastal erosion sector can achieve a whole life cost-benefit ratio of 1:9 or higher (i.e. the benefits from risk reduction projects are 9 times the cost).

Given the range of policy tools that need to be considered, overcoming the challenges to a holistic approach to the financial management of flood risk requires effective coordination across government ministries and levels of government, supported by strong leadership aimed at addressing the financial vulnerabilities created by exposure to flood risk.

Key questions for discussion

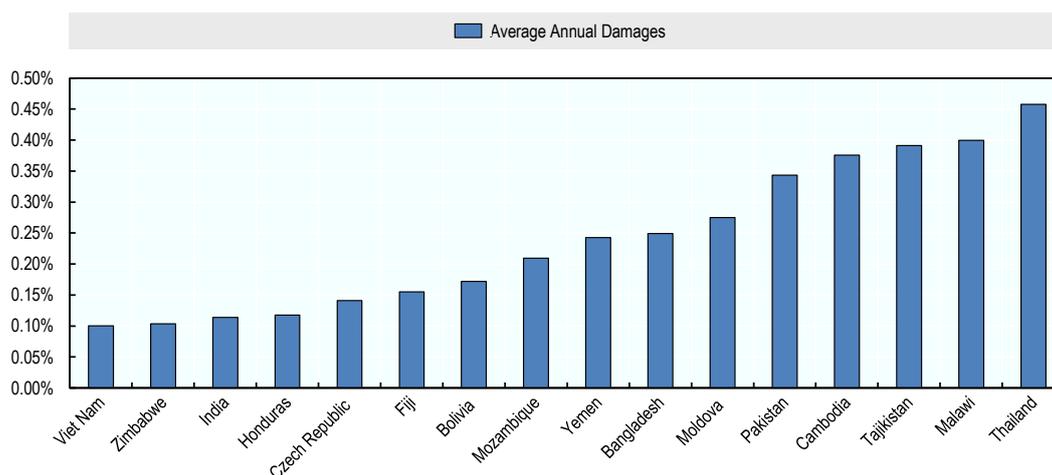
- What are the relative merits of investing in prevention, preparedness and financial protection?
- Are there limits to the contribution that each of these types of investments can make? What kind of metrics are used to evaluate the potential contribution of different investments?
- What are the benefits of considering the relative contributions of each type of investment in a holistic way? How should the relationship between different types of investments be considered when evaluating different financial management options?

Session 3: Building financial resilience against flood risk in developing countries (co-organised with the World Bank)

Developing countries face particular challenges in terms of the financial management of flood risk as a result of more limited resources for investing in *ex ante* risk reduction and *ex post* response, lower levels of insurance market development, and more restricted access to international insurance and capital markets. While the direct and indirect losses from disasters can have a significant impact on any economy, these impacts are particularly severe for developing countries, and the poorest households within those countries, due to their more limited capacity to manage disaster risks (Von Peter, von Dahlen and Saxena, 2012).

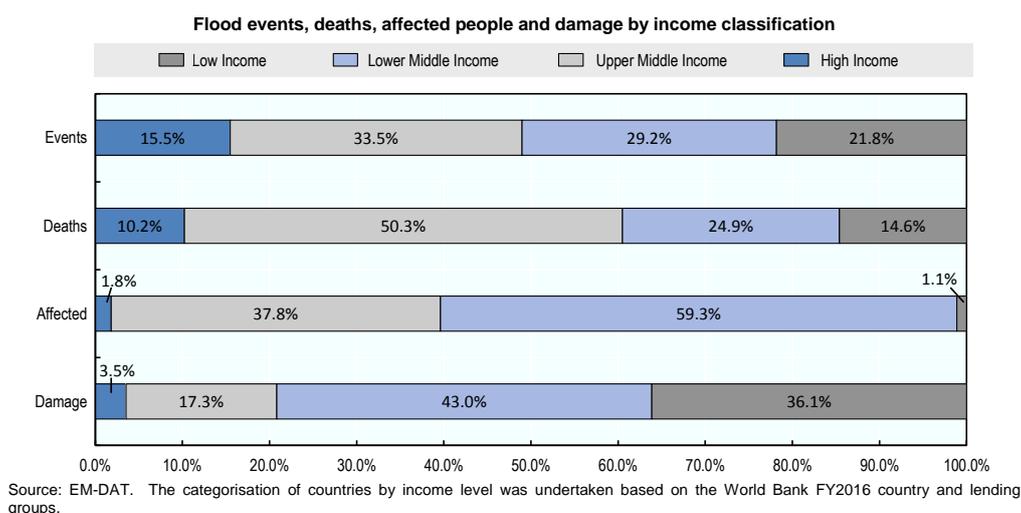
A number of developing countries are particularly exposed to flood risk. Among the 22 largest flood loss events since 2000 (including flooding related to tropical cyclones), ten have occurred in developing countries, including the 2011 floods in Thailand, the 2010 Indus river floods in Pakistan, Typhoon Haiyan in the Philippines in 2013, monsoon flooding in Mumbai in 2005 and in India, Pakistan and Nepal in 2004, and flooding in various parts of China in 2003, 2004, 2007, 2010 and 2012 (Kron, 2015). According to the EM-DAT data, since 1990, seven developing countries experienced at least one year of flood damages exceeding USD 5 billion (including Bangladesh, China, India, Iran, North Korea, Pakistan, Thailand). In some countries, annual average recorded damages have accounted for a material share of GDP.

Annual average damage from flood events as a share of GDP



Source: EM-DAT. Annual average damage was calculated based on damage reported between 1971 and 2015 and converted to constant 2015 USD based on the US Bureau of Labor Statistics' *Historical Consumer Price Index for All Urban Consumers (CPI-U)*. GDP figures are from the World Bank for the year 2014 (most recent year available) at current USD (<http://data.worldbank.org/indicator/NY.GDP.MKTP.CD>).

The impact of flooding also varies substantially with the level of income of the affected country (which is usually a gauge of the level of a country's resilience against flood risk). Lower income countries tend to face higher deaths from flood events while higher income countries face higher levels of damage. While 49% of flood events recorded in EM-DAT between 1971 and 2015 have occurred in countries considered low income or lower middle income, more than 60% of all deaths and less than 21% of all damage has occurred in those countries.



As a result of lower levels of insurance market development and more limited capacity to pay for many households, the share of losses covered by insurance markets is much lower in developing countries. For example, in East Asia and the Pacific, the average non-life insurance penetration rate (i.e. premiums as a share of GDP for broad non-life coverage, not just floods) is approximately 50% of the penetration rate in Europe and 35% of the penetration rate in North America (Jha and Stanton-Geddes, 2013). In Latin America, non-life penetration rates range from less than one quarter of the United States' penetration rate in Peru and the Dominican Republic to approximately half of the United States' rate in Brazil, Colombia and Chile (Swiss Re, 2016). Microinsurance may provide a mechanism for offering some financial protection against flood risk. Such products can potentially be offered at an affordable price where payouts are relatively small and calculated based on parametric weather triggers (index insurance) rather than indemnity triggers and where efficient distribution channels are available. However, few products have thus far been able to demonstrate economic viability and/or generate significant scale and many microinsurance initiatives have been dependent on continued support from donor funding.

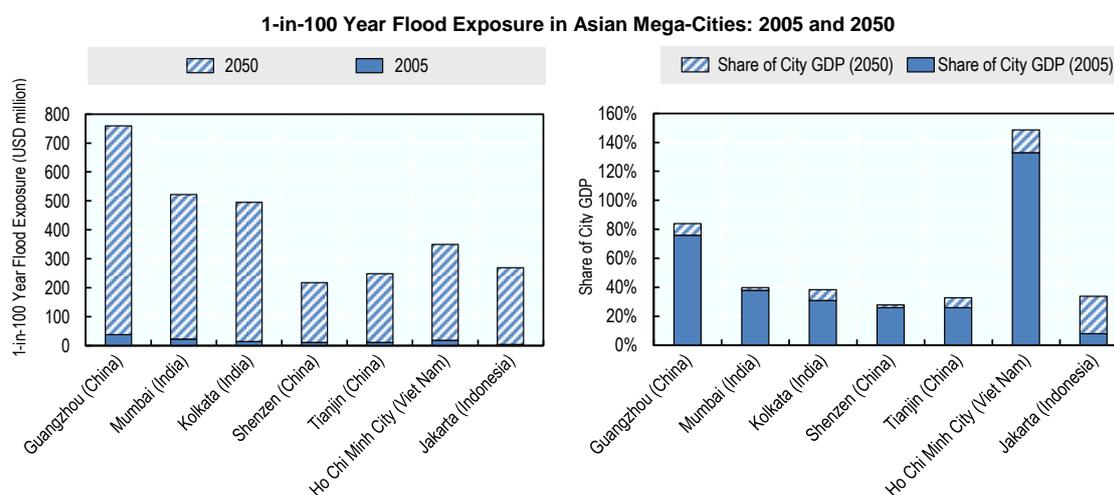
Limited insurance penetration means a larger share of losses must be absorbed by households, businesses and government which often have more limited capacity to absorb those losses. Developing countries with more limited access to capital markets (or facing particularly large exposures to flood risk) can establish contingent credit lines with multilateral or bilateral development agencies. The World Bank and Inter-American Development Banks offer such facilities as does the Japan International Cooperation Agency (JICA) and a number of countries have established such lines of credit.

Key questions for discussion

- What unique challenges do emerging economies face and how can approaches to managing the financial impact from floods in OECD member countries be adopted to their specific context and circumstances?
- How should countries decide between investing in flood risk reduction and better managing the financial impacts of residual risk?
- What innovative ways of strengthening financial resilience to floods are being implemented in emerging economies?
- What are the roles and opportunities for international partners such as multilateral organisations, the private sector, or technical agencies to support emerging economies in further strengthening financial resilience to floods?

Session 4: Managing flood risk at the city-level

Cities are particularly vulnerable to flood risk given the concentration of assets, the tendency for cities to be located close to water and the negative impacts of built-up areas on groundwater absorption – particularly in the context of a changing climate. Based on urban land-use projections, an estimated 13% of urban land will be located in “low-elevation coastal zones” vulnerable to flooding and 40% of urban land will be located in high-frequency flood zones by 2030 (from 11% and 30%, respectively in 2000), with developing countries accounting for an increasing share of that exposure as a result of more rapid urbanisation (Güneralp et al., 2015). In Asia, a number of mega-cities are located in coastal areas and are expected to face substantial increases in potential losses as a share of city GDP as a result of population growth and economic development, sea-level rise and subsidence.



Source: OECD calculations based on Schanz and Wang (2015) and Hallegatte et al. (2013).

In the United States, estimates by RMS (2015) suggest that the probability of events causing at least USD 10 billion in storm surge losses will increase significantly by 2100 as a result of sea-level rise in a number of US coastal cities, including from 2.22% to 5.26% in Tampa, Florida; from 1.28% to 5.88% in Miami, Florida; and from 0.87% to 3.70% in New York, New York.

The concentration of economic activity in cities means that a major flood could have significant economic consequences. The Lloyd’s City Risk Index: 2015-2025 (2015) estimates that USD 432 billion of economic output is at risk from coastal and riverine flooding in 301 cities analysed, including more than USD 10 billion in each of the seven most exposed cities (Tokyo, Osaka, Los Angeles, New York, Sao Paulo, Delhi and Taipei). An OECD analysis (2014) of the potential economic impacts of a major flood of the Seine river in the greater Paris region found that the impact of infrastructure disruptions on businesses’ operating losses (particularly as a result of power and transport disruptions) were estimated at EUR 19 billion in the most extreme scenario, or almost 65% of the direct losses of EUR 29.4 billion estimated for that scenario.

In most countries, cities have jurisdiction over many of the measures that can improve flood resilience, such as land-use planning, protective structures and the flood resilience of local public infrastructure. Not unlike national governments, municipal authorities need to evaluate the most effective way to manage their exposure to flood, considering the potential roles of investments in risk reduction, risk transfer and *ex post* response.

Land-use planning can have a significant impact on flood risk by reducing the level of assets at risk of flooding (i.e. restricting development in flood zones) and therefore slowing the accumulation of assets exposed to flood risk. Land-use planning can also provide allowances for natural flood protection mechanisms, such as green spaces and mangroves, that can also make an important contribution to enhancing water absorption and protecting against storm surge. This is more challenging in highly-built up cities with limited land availability although innovative approaches are

being considered in many urban areas, such as designing streets to act as urban waterways for the drainage of rain waters in Copenhagen or the installation of permeable pavement in London.

Structural flood mitigation measures, such as dams, levees, reservoirs and polders, may be used to reduce flood risk by protecting areas from a given level of inundation and therefore reducing the frequency of flooding - and may be the only cost effective approach to reducing flood risk in built-up areas located in flood plains. In Hamburg, the coastal flood protection infrastructure that was reinforced after a storm surge in 1962 (at a cost of approximately EUR 2.2 billion) has protected the city from coastal flooding four times since, resulting in estimated savings of EUR 17.5 billion in losses not incurred (Munich Re, 2012). In New Orleans, significant investments in flood protection since Hurricane Katrina, including a USD 14.5 billion storm surge defence system as well as the adoption and enforcement of stricter building codes across the state of Louisiana, would lead to an estimated USD 54 billion in reduced losses from a similar storm in the future (despite a 40% increase in insured values) (AIR Worldwide, 2015).

Land-use planning, large-scale structural mitigation and household risk reduction measures to address flood risk should be considered in a holistic way to be effective. For example, structural investments risk being ineffective if not supported by appropriate land-use controls. Without appropriate land-use controls, investments in flood defences could encourage development of newly-protected areas which could increase losses were the defences to be breached. The objective for flood risk management planning should be to find an optimal portfolio of the flood risk management tools available, weighing the costs and benefits of the different investments and taking into account the cumulative benefits from different types of tools when combined. One approach might be to consider different possible flood risk reduction investments as a portfolio of investments and aim to optimise the return (and minimise risk) across a set of possible flood risk reduction investments (Aerts et al., 2008). This approach formed the basis of an evaluation of possible flood risk management strategies in New York City that considered the potential benefits of enhanced building codes, large-scale coastal defences and a combination of approaches (Aerts et al., 2014).

Land-use restrictions and structural mitigation measures can entail significant costs (including lost revenues) for municipal governments as does the rebuilding of public infrastructure after a major flood. Insurance companies might be a potential source of financing for structural mitigation. Insurance companies manage more than USD 28 billion in assets on behalf of policyholders and third parties (OECD, 2015) and have a self-interest in supporting investments in resilience as a means of reducing losses over time. Governments could capitalise on this potential demand from insurance companies for supporting investments in resilience by issuing bonds for the express purpose of financing such investments. This emerging bond type, known as “resilience bonds” or “municipal adaptation bonds”, is similar to the concept of “green bonds” whereby the issuer commits to use the funds for specific “green” purposes (in fact, investments in climate change adaptation is included as an eligible use of funds under the Green Bond Principles and the Climate Bonds Standard and Certification Scheme, which aims to establish standards for “green” municipal bonds, includes investments in flood mitigation as an eligible investment with the proceeds of a green municipal bond (US Green City Bonds Coalition, 2015)). The City of New York announced in 2014 that it intended to issue (“green”) bonds for the specific purpose of financing projects that would boost resilience to climate change (Owens, 2014). Green bonds have also been issued by Nederlandse Waterschapsbank (NWB Bank) to finance loans to Dutch water authorities for water management measures, including flood protection measures (Kidney, 2016).

The potential for private investment in resiliency projects is limited by the challenge in structuring an approach that provides the investor (e.g., insurance companies) with returns over time. Unlike toll roads or airports, structural mitigation projects such as flood barriers do not generate future revenue with which to repay investors and are therefore usually financed by public funding. One approach put forward to address this barrier is to link investments in resilience to pre-defined rebates on catastrophe bonds that could be used to fund the project costs (Vajjhala and Rhodes, 2015) - although a significant increase in interest in catastrophe bond issuance by public agencies would be a prerequisite.

Municipal authorities could also consider some form of risk transfer to protect against flood risk, whether through the acquisition of insurance for public assets or the use of catastrophe bonds. A public authority, the New York Metropolitan Transit Authority which is responsible for public transit in New York City, issued a catastrophe bond in 2013 to cover storm surge risk using a parametric trigger based on a storm surge height threshold for a named storm (Guy Carpenter, 2015).

Key questions for discussion

- How can cities better account for flood risk in land-use planning and infrastructure investments? How critical is it to engage national authorities in building city resilience?
- What approaches can cities use to manage the financial impacts of floods? What types of financial protection tools are available to cities to cover flood risk?
- Does rapid urbanisation present an opportunity for cities to take greater responsibility for the management of flood risk? Will rapid urbanisation and/or devolution of authorities to cities have a long-term impact on the level of urban flood protection and the type of financial protection and instruments accessed?

Session 5: Protecting households against flood risk – comparing the different approaches across OECD countries

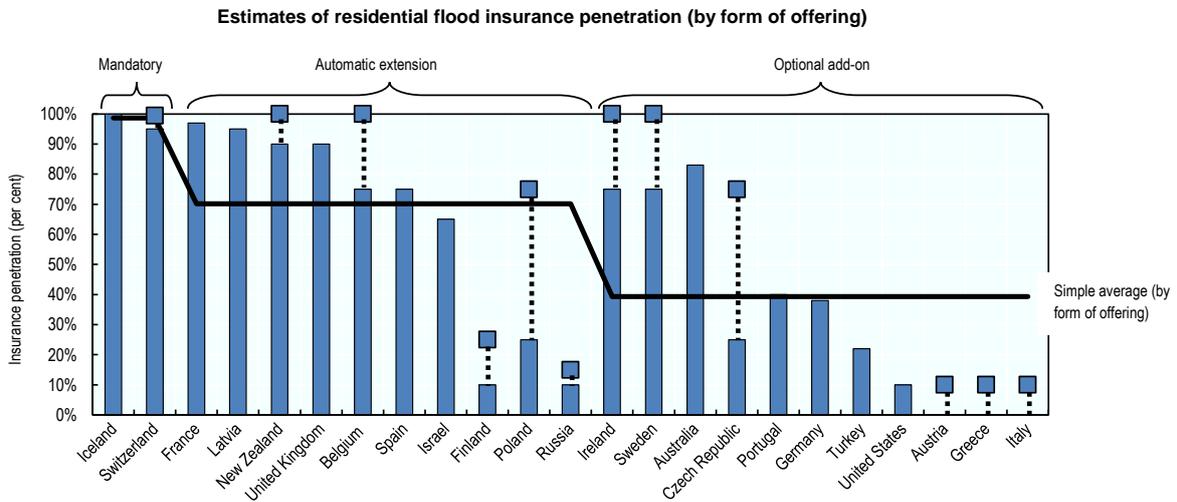
There is a wide variety of approaches across countries to protecting households and businesses against flood risk. In many countries, private insurance companies offer coverage for flood-related damages and losses, either as part of standard property and business interruption policies, or available as an optional add-on to such policies. In some countries, coverage for flood damage may only be available from a public insurer, especially for properties deemed to be at high-risk of flooding. In other countries, government assistance may be the only source of compensation available for losses from flood events. These different approaches to financial protection have been designed with the aim of achieving different policy objectives, such as broad availability and affordability of coverage, solidarity in terms of loss-sharing across regions, establishment of clear incentives for risk reduction and/or significant transfer of risk to private markets.

Insurance arrangements for flood risk

Country	Coverage Provider		Form of Coverage		Description
	Private	Public	Automatic extension	Optional Add-On	
indicates motor vehicle coverage; indicates residential property coverage; and indicates commercial property coverage.					
Australia			 (flash flood)	 (riverine flood)	A distinction is made between damage caused by flash floods and riverine floods. Coverage for flash flooding is generally included in standard policies. Insurers are required to offer riverine flood coverage as part of standard cover, but may derogate if disclosed to the policyholder. Consumers have a wide choice of products: 86% of policies selected by consumers have flood cover as a standard inclusion, with no opt-out option; 7% of policies are sold with flood cover as an inclusion, but with the opportunity to opt-out; and 7% of policies sold derogate flood cover entirely. Flood insurance is sold on a risk-based pricing basis and is not cross subsidised.
Austria					"First risk" coverage for flood damage is automatically extended to standard residential fire policies. Extended coverage is available on an optional basis.
France		 (reinsurance)			Private insurers automatically extend coverage to include natural disasters (at a flat rate) and can reinsure up to 50% of their natural disaster exposure with a public reinsurer (CCR). CCR is provided with an unlimited state guarantee for losses incurred.
Spain		 (direct insurance)			An extraordinary risk cover clause is mandatorily included in property, life and personal accident policies and a mandatory surcharge is applied. The risk is assumed by CCS (provided it is not assumed by the insurance company on its own). CCS is provided with an unlimited state guarantee in case its resources are exhausted although the guarantee has never been called).
United Kingdom		 (reinsurance)			Private insurers can transfer risks related to their coverage of certain high-risk properties to Flood Re, an industry established pool.
United States		 (direct insurance)			The public National Flood Insurance Program (NFIP) provides flood coverage for residential properties in eligible communities. Private insurers may also provide alternative or excess coverage for amounts above the maximum level of NFIP coverage (excess flood insurance) as well as coverage for additional living expenses (which is not covered by the NFIP).

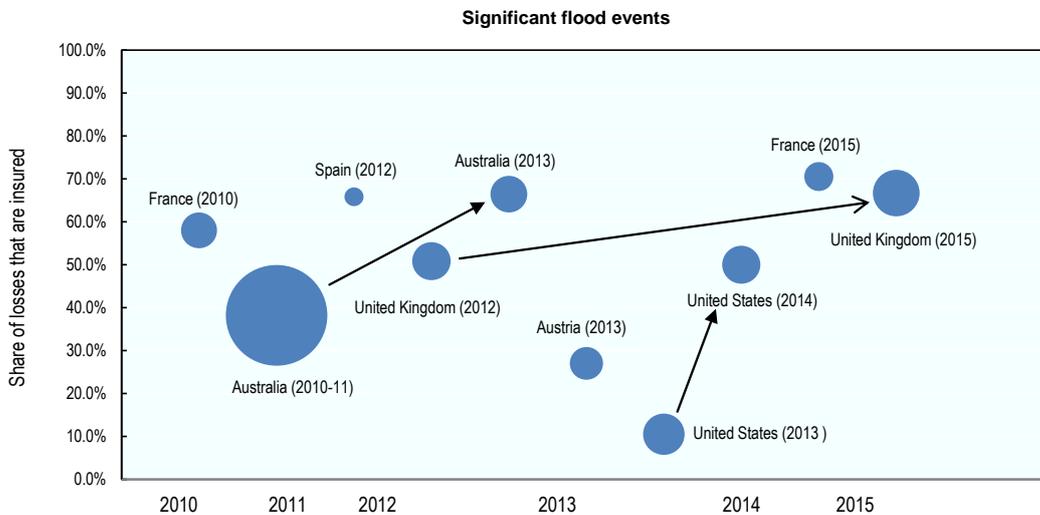
There are clear trade-offs between these different approaches. For example, broad availability and affordability of coverage and/or solidarity across regions usually entails some form of cross-subsidisation across policyholders with implications for the strength of incentives to encourage risk reduction. In some instances, a reliance on private markets (and full risk-based pricing) may come at the expense of availability of affordable coverage for high-risk properties. In countries where flood risk is automatically included in standard building and contents insurance for households and

businesses, required by mortgage lenders (and effectively enforced) and/or offered as a default option for insurance coverage, penetration rates are generally higher.



Source: Most of the information on penetration rates (share of households with flood insurance coverage) was taken from country responses to an OECD questionnaire on the financial management of flood risk (2015). The estimated penetration rate for Australia is from OECD (2015); the estimated ranges for penetration rates in Belgium, Czech Republic, Finland, Greece, Ireland, Italy and Poland are from Maccaferri, Carboni and Campolongo (2012); for the UK, the estimate is from DEFRA (2013); and for Germany, the estimate is from German Insurance Association (2015b). The dashed lines represent the range of estimated penetration rates (minimum estimate to maximum estimate). The solid line indicates the simple average across each type of offering.

Some countries have seen significant increases in the share of losses covered by insurance for significant events over time, including Australia, the United Kingdom and the United States.



Source: Data on insured losses and total losses is from Swiss Re sigma annual reports on natural and man-made catastrophes (except for Austria which is from ICPDR (2014)). The size of the bubbles represent the magnitude of overall losses reported for the event.

The different approaches also have different implications in terms of the government’s role after a flood event. In general, lower levels of insurance coverage for flood damage leads to greater pressure on governments to compensate for uninsured damages. For example, the 2015 flooding in Cumbria and Yorkshire in the United Kingdom and the 2013 flooding in Colorado in the United States led to relatively similar levels of overall losses (USD 2.4 billion relative to USD

1.9 billion) although, with a much lower level of insured losses in the United States, the level of national government assistance was significantly higher than in the United Kingdom (USD 1.2 billion (or 66% of overall losses) (FEMA, 2014) relative to GBP 200 million (USD 285 million or 12% of overall losses) (DEFRA, 2016)).¹

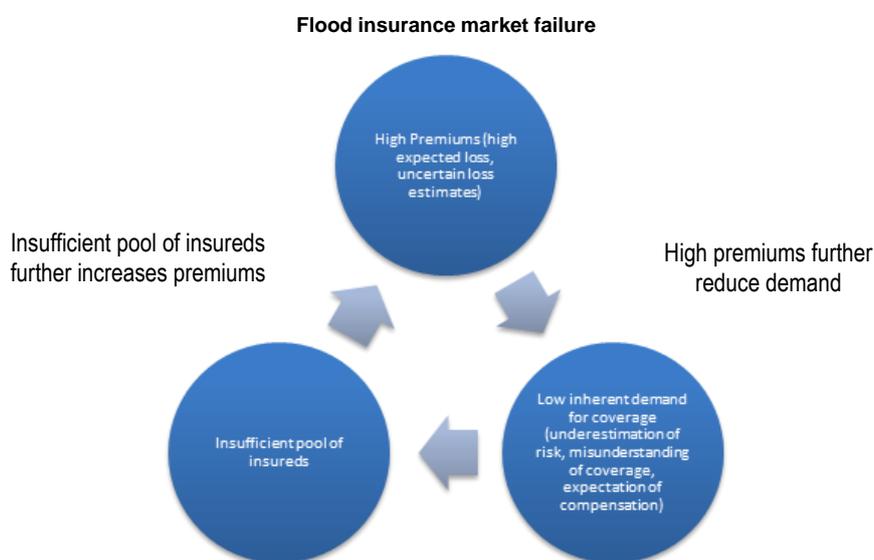
Key questions for discussion

- Is it feasible for private insurance markets to provide coverage for high-risk properties? What can the public sector do to support private coverage? Is some form of compulsion necessary to avoid underinsurance?
- What are the biggest challenges and barriers to flood insurance - technical (complexity of flood risk, risk data & models), political (affordability), regulatory or commercial?
- Is there any alternative to government compensation for flood losses faced by vulnerable (low-income, flood-prone) populations or in countries where property insurance penetration is limited? Does such compensation create fiscal risk?
- What are the impacts of different approaches to financial protection on incentives for risk reduction?
- How do the different insurance systems deal with a changing climate?

¹ Differences in the level of assistance from national governments could be the result of other factors, in addition to the level of insurance penetration, including differences in local vs. national responsibilities and financial capacity across countries. As the UK floods were more recent (December 2015), the amount of national government assistance could also still increase.

Session 6: Supporting insurability and affordability – challenges and innovations

Ensuring the broad availability of affordable flood insurance is a key challenge in many countries - leading to significant government intervention in providing (re)insurance coverage for all or high-risk properties and/or subsidising premiums (explicitly or implicitly) to support affordability. There are a number of factors that affect the price at which insurance companies are willing to offer coverage for flood risk, including the scale of potential losses, the lack of diversity in the pool of risks covered (where flood insurance is optional) as well as the level of uncertainty in estimating expected losses (due to modelling challenges and a changing climate). While these insurability challenges generally lead to higher prices for flood insurance, a number of factors tend to reduce the demand/willingness-to-pay for flood insurance, including the tendency towards underestimation of risk, misunderstandings about coverage and expectations of post-disaster public compensation or financial assistance – leading to a market failure in the flood insurance market.



Both the public sector and the insurance sector have important roles in addressing these challenges. Governments have a critical role in supporting the insurability and affordability of flood risk through effective land-use planning, by investing in - and providing financial support for - structural (community-level) and household risk reduction measures and by enhancing flood risk awareness. This requires strong leadership and coordination across government ministries and different levels of government, given the range of policy tools that need to be considered as well as the decentralised nature of responsibilities for these issues in many countries. Insurance companies, associations and brokers have a clear role to play in raising awareness of flood risk among their customers and the consequences of not protecting themselves against the financial implications of a flood event.

Risk-based premiums can provide an important price signal on the level of exposure and a financial incentive for risk reduction. Insurance companies (where free to set premiums) have an important role in providing this price signal by underwriting coverage based on detailed assessments of flood risk at the property-level as well as by providing premium discounts for mitigation measures that effectively reduce exposure to damage. However, premium discounts for residential properties are only provided by insurance companies in a few countries and only for a select set of risk-reduction measures (partly due to the challenge of ensuring that risk reduction measures are properly implemented and will be effective in reducing risk). To address this, public-private collaboration has facilitated the establishment of certification programmes in a number of countries that aim to translate risk-reduction investments into premium discounts. For example, in Germany, a programme has been established to allow households in flood exposed areas to obtain a flood resilience certificate that is based on an extensive risk assessment by authorised experts. Where premiums are not risk-based, the availability of insurance could encourage development/construction in flood-prone areas and increase the overall level of flood exposure – which needs to be addressed through strong land-use and building standard requirements.

High-risk areas, often developed before the true level of flood risk was known, require particular attention given the difficulty of providing a viable insurance offering to households in those areas. In most countries, the proportion of properties facing high levels of flood risk is relatively small although these properties often account for a material share of overall losses. For example, in the United States, high-risk (repetitive loss) properties accounted for 38% of all claims payments between 1978 and 2004 (General Accounting Office, 2004). Given the size of expected losses for such properties, premium rates for high-loss properties are often unaffordable. The actuarially-sound annual premiums for properties prone to severe flooding (more frequently than 1-in-50 years) or that might be destroyed by storm surge more than once in a hundred years would exceed 1% of the value of the property. Even if expected damage from a 1-in-50 year flood is only 25% of the value of a property, expected annual losses on that policy would still be equivalent to 0.5% of the value of the home (or 2 500 for a home with a value of 500 000).

Estimates of the share of properties at high-risk of flooding

Country	Estimate
Australia	Riverine flooding: 7% of domestic houses ¹ 1-in-100 year flooding: 160 000 homes ²
Austria	Flooding (1-in-30): 150 000 exposed people ³ Flooding (1-in-100): 350 000 exposed people ³ Flooding (1-in-300): 650 000 exposed people ³
Canada	Flooding (1-in-75): 13% of residential properties ³
Czech Republic	Flooding (1-in-50): 9%-10% of households ³
Estonia	Flooding (1-in-50): 6 708 residents ³ Flooding (1-in-100): 9 171 residents ³
Germany	Flooding (1-in-50 to 1-in-200): 7.9% of households ⁴ Flooding (1-in-50 or higher): 1.9% of households ⁴
Ireland	Flooding: 300 communities identified as facing significant risk of damaging floods (based on index of hazard and consequences) ⁵
Italy	Flooding and landslide (high-risk): 1.1 million residential buildings (9% of total) ⁹
Latvia	Flooding (1-in-75): <1% ³
Portugal	2% of mainland Portugal displays high or very high vulnerability ⁶
Russia	7400 settlements are located in "flood hazard areas" ³
Spain	Flooding (1-in-100): 3.3% of population ³
United Kingdom	Some degree of flood risk: 6 million properties (16.7%) ⁷ Riverine and coastal flooding (1-in-75): 560 000 properties (England and Wales) ⁷
United States	Riverine flooding (1-in-100): 4.9 million housing units ⁸ Coastal flooding (1-in-100): 3.8 million housing units ⁸ Coastal flooding (1-in-100): 16.4 million residents (5% of population) ³

Sources: ¹Allianz Australia Insurance Ltd. (2011); ²Collins and Simpson (2007); ³Country responses to an OECD questionnaire on the financial management of flood risk (2015); ⁴German Insurance Association (2015); ⁵Office of Public Works (2012); ⁶Costa et al. (2014); ⁷Ramsbottom, Sayers and Panzeri (2012); ⁸National Research Council (2015); ⁹Swiss Re (2015)

In many countries, this issue is addressed by providing some form of premium subsidies to high-risk properties (either as a cross-subsidy in countries where premium pricing is flat or through explicit subsidies provided as premiums below actuarially-based rates). However, the use of premium subsidies can be expensive and difficult to remove, are likely to exacerbate moral hazard and have limited (or no) impact in terms of reducing the level of risk. Consideration should be given to allocating government assistance to risk reduction investments instead of premium subsidies in order to reduce the overall level of exposure over time. For example, means-tested vouchers could be provided by the public sector to those who undertake cost-effective mitigation measures – which could help address the affordability issue. Homeowners who invest in loss-reduction measures could be given a premium discount to reflect the reduction in expected losses from floods. Long-term loans for mitigation could encourage investments in cost-effective mitigation measures. Well-enforced building codes and seals of approval would provide an additional rationale for undertaking these loss-reduction measures (Kousky and Kunreuther, 2014).

The form of insurance coverage can also have important implications for the level of take-up. The automatic extension of general property insurance coverage to include protection against flood damage as well as approaches that include flood coverage as the default option for insurance policies have led to significantly higher levels of flood insurance penetration. Requirements for flood coverage as a condition for mortgage financing have also been successful in encouraging take-up.

Where insurance coverage for flood is an optional add-on to property policies, investments in improving public understanding of flood risk and the need for financial protection will likely be necessary for generating sufficient demand for flood insurance. There is some evidence that forms of risk communication that focus on return probabilities within shorter time periods, build on recent flood experience and provide estimates of the potential level of flood damage may be more effective in encouraging households and businesses to seek financial protection. Minimising misunderstandings about the scope of flood coverage as well as clarifying the extent of possible public disaster assistance (and not providing compensation for damage that was otherwise insurable) is also important for increasing the demand for flood coverage.

Key questions for discussion

- Is it possible to increase homeowners' willingness-to-pay for insurance through better risk communication? What types of approaches have been most effective in terms of enhancing homeowners' awareness of flood risk?
- What types of mitigation investments are most effective in reducing flood risk? How can the public and private sectors provide incentives to homeowners and communities to reduce their exposure to flood risk?
- What are the roles of the public sector and insurance sector in supporting such initiatives? What impact can these have on the affordability of insurance coverage?

www.oecd.org/daf/fin/insurance/2016-oecd-conference-financial-management-flood-risk.htm

