

The Role of Insurance in Reducing Direct Risk — The Case of Flood Insurance*

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ABSTRACT

The provision of flood insurance is a patchwork, with countries showing varying degrees of penetration, coverage types, demand levels, and design structures. This article explores the current understanding of flood insurance with a specific focus on the ability of flood insurance to contribute to direct risk reduction. The starting point is a consideration of the existing provision of flood insurance, both in established insurance markets and in developing countries. A review of efforts to analyse and explain the use and design of flood insurance highlights how the understanding of supply and demand determinants is steadily growing, while clear gaps also emerge. Particularly the question of utilizing flood insurance in the context of climate change and as a lever for physical risk reduction would benefit from further empirical and theoretical analysis. The article concludes with a reflection on current efforts to reform and design flood insurance and offers some pointers for future research.

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1 Introduction

Everyday many individuals, organizations, governments, and businesses buy insurance to transfer the risk of facing an uncertain loss in exchange for paying a certain premium. This mechanism has been used for centuries, reducing the uncertainty of financial loss by spreading risk across a large number of the insured. It has become an important cornerstone not only of economic activity but also of social policy: without insurance many activities and processes would be deemed too risky and would not be undertaken, and those affected by a loss might struggle to recover.

Today, insurance is available to cover virtually any type of risk — as long as there is supply and demand for the risk transfer. One area that has recently seen a surge in political debates, academic research and commercial explorations is that of flood insurance, aimed at covering the direct impacts of flood events, such as property damage and business interruption.¹

Floods are one of the most wide-reaching and commonly occurring natural hazards in the world, affecting on average about 70 million people each year (UNISDR, 2011). Recent loss trends are rising, largely due to socio-economic factors, while climate change is also expected to exacerbate the impacts of flooding (IPCC, 2012, 2014).

The rapid increase in global economic losses from flooding has re-intensified discussions among private insurers, governments, and international organizations about the role of insurance in addressing these risks. The discourse follows two broad strands: reform efforts for existing insurance schemes, such as systems in the United Kingdom and the United States; and efforts to design new schemes in less established markets, for example, see Swenja Surminski and Delioma Oramas-Dorta (2013).

While this is foremost a question of sharing risks and distributing the costs of compensation and recovery, there is a further dimension beyond financial preparedness: purchasing an insurance risk transfer product can influence

¹ Indirect risks arising from policies and actions taken to respond to those risks are beyond the scope of this review. See for an overview: Surminski (2013).

the behaviour of those at risk. This can either be in a moral hazard² context, where insurance can lead to a more risky behavior, or as an incentive, where insurance can trigger risk reduction investments or the implementation of prevention measures (see for example the work of Kunreuther and colleagues at Wharton: Kunreuther, 1996; Kunreuther *et al.*, 2013; Kunreuther and Michel-Kerjan, 2009; Kunreuther and Pauly, 2006) and the work at IIASA by Mechler and Linnerooth-Bayer (Linnerooth-Bayer and Mechler, 2009; Linnerooth-Bayer *et al.*, 2011).

With the prospect of growing impacts from flooding due to climate change and socio-economic growth this prevention role of insurance appears to have received renewed attention from policy makers: In 2013, the European Commission (EC) launched the Green Paper on the insurance of natural and man-made disasters (EC, 2013), which reflects on the concerns about rising risk levels and how this can be accommodated through new and existing flood insurance schemes. The consultation document frames insurance in two ways: the question of availability and affordability, and the potential to use insurance as a lever for flood prevention and disaster damage mitigation. The EC specifically asks in the consultation how risk transfer can reduce disaster risks today and into the future.

A review of the evidence from the literature and the market suggests the following answer: ‘yes in theory, not really in practice’ (see, for example, Botzen and van den Bergh, 2009; Mills, 2009; Surminski and Oramas-Dorta, 2011). Why is this the case?

This article aims to shed more light on this question by reviewing the current understanding of flood insurance. The starting point is a consideration of the existing provision of flood insurance, both in established insurance markets and in developing countries (Section 2). A review of efforts to analyse and explain the use and design of flood insurance (Section 3) highlights how the understanding of supply and demand determinants is steadily growing, while clear gaps also emerge. Particularly the question of utilizing flood insurance in the context of climate change and as a lever for physical risk reduction would benefit from further empirical and theoretical analysis (Section 4). The article concludes with a reflection on current

² Moral hazard occurs when a member of the party acts conversely to the principles set out in an agreement between those parties. For example in an insurance contract, the individuals’ motives and behaviour to prevent loss may be reduced if financially protected through a policy, thus resulting in an increased probability of loss. For more detail on moral hazard, please see Arrow (1968) and Pauly (1968).

efforts to reform and design flood insurance and offers some pointers for future research (Section 5).

2 The Flood Insurance Status Quo

The use of insurance for the management of flooding and other natural disaster losses differs widely across the world (for example, see Paudel *et al.*, 2012). Penetration rates, types of products and operational mechanics of insurance schemes vary from country to country. This range of approaches is determined by several factors including risk drivers, cultures, regulatory demands, and the economic environment (Brainard, 2008; Feyen *et al.*, 2011, Hussels *et al.*, 2005; Swiss Re, 2004; USAID, 2006). Below is an overview of the current set-up of flood insurance.

2.1 *Where is Flood Insurance Available?*

Estimates indicate that in developing countries only 5% of direct natural hazard disaster losses are insured as compared with 40% in developed countries (DfiD, 2013). This picture corresponds to a large extent with the uneven application of general insurance across countries, with risk transfer still in its infancy in most developing countries (see CEA, 2011a). However, for low and medium income countries there is evidence of a range of new schemes being implemented. These are often in response to existing demand and supply challenges, testing new innovative forms, such as micro-insurance, or index-based risk transfers. The ClimateWise Compendium (ClimateWise, 2011a) on disaster risk transfer, documents 123 existing initiatives in middle-income and lower-income countries that involve the transfer of financial risk associated with the occurrence of natural hazards such as flooding (Surminski and Oramas-Dorta, 2011). Recent examples are the African Risk Capacity Facility³ (ARC, 2014) and the introduction of index-based flood insurance⁴

³ The African Risk Capacity Facility (ARC) is a specialised agency proposed and led by the African Union and aims to support extreme weather events and natural disaster risks through establishing a risk pool into which donors and member countries pay an annual premium. The scope of the scheme is supported throughout the whole of Africa and aims to insure the risk of drought in the Sub-Saharan area. Although currently at design stage and subject to change, the ARC is a solidaristic approach providing government with much needed disaster financing and the capacity to rapidly distribute funds for post-emergency services (ARC, 2014).

⁴ Index based insurance is insurance that indemnifies all policyholders in a defined geographic area for when a particular threshold is passed based on certain criteria. This maybe crop or livestock losses or weather related parameters such a particular temperature or level of rainfall,

in Peru termed the Extreme El Nino Insurance Product (EENIP)⁵ (Global-AgRisk, 2013).

Even within well-developed insurance markets clear differences with regards to the provision of flood insurance exist, as the example of Europe demonstrates (see Penning-Rowsell *et al.*, 2014). Some observers identify a growing ‘flood resilience gap’ in developed markets — with the level of insurance cover for flood and other disaster losses being fairly static, while state disaster relief expenditure is increasing, as recently seen in the United States (Weiss and Weidman, 2013).

Summaries of existing coverage from the European insurance and reinsurance federation (CEA, 2009) identify a patchwork of schemes, with the extent and scope of risk transfer varying from country to country (Table 1), and — as the case of Germany shows — even across regions within a country. The Netherlands does not have flood insurance beyond some commercial policies, despite several efforts over the last few years to introduce residential cover (see for example Botzen and van den Bergh, 2008; Surminski *et al.*, 2014).

The data provision that underpins these overviews is fairly limited — for most countries this is based on aggregate estimates — and more specific breakdowns of who buys a particular type of insurance (gender, age, social status and other aspects) are generally not available. The aggregate penetration data also does not differentiate between public and privately provided insurance cover. The current picture therefore gives an indication of insurance levels within a country, but does not allow more detailed analysis of their features.

and is often based on aggregated criteria. The cost of setting up and administering an index based scheme is often much lower as well as avoiding the issues of moral hazard and adverse selection. However, one limitation is basis risk whereby any risk not reflected in the index results in loss. This may occur for several reasons including, if the measurement for the index threshold as used by the insurers’ differs to that of the policyholders, and when the calculation for the index does not cover a ‘useful’ risk or fully reflect the risk in question. Managing this basis risk is essential when scaling up index insurance schemes to prevent policyholders being exposed to risks not covered in the index and in fact increasing their risk overall (IFAD, 2011).

⁵ The Peruvian Flood Index (ENSO) insurance scheme is an index based scheme aimed at businesses in an effort to prevent business interruption. It also addresses risk awareness through capacity building initiatives. The scheme has been developed by GlobalAgRisk and sold by La Positiva, a Peruvian insurer. The index is based on sea surface temperature as a proxy for loss. Different contracts are available with different threshold losses, with a maximum payout at a temperature of 27°C (ClimateWise, 2011a).

Table 1. Insurance coverage and penetration rate for different natural catastrophes across Europe.

	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Greece	Italy	Netherlands	Norway	Poland	Portugal	Spain	Sweden	Switzerland	Turkey	United Kingdom
Storm	O	C ¹	O	O	O	C	O	S	N	O	P	O	O	P	O	C	O	O
Cyclone/hurricane	O	C ¹	N	O	O	C	O	S	N	O	P	N	O	P	O	C	O	O
Floods	O	C ¹	O	N	O	C	S	S	O	N	P	O	O	P	O	C	O	O
Hail	O	O	O	O	O	O	O	S	O	O	S	O	C ²	O	O	C	S	O
Landslides	O	C ¹	O	O	O	C	S	S	O	S	P	O	O	S	O	C	O	O
Snow	O	O	O	O	O	O	S	S	O	O	N	O	N	O	O	C	O	O
Frost	O	O	O	O	N	O	O	S	O	O	O	O	N	O	O	O	N	O
Avalanche	O	N	O	N	O	C	S	N	O	N	P	O	N	O	O	C	N	N
Drought	O	N	S	N	N	C	N	N	N	N	N	N	N	S	O	N	N	N
Subsidence	O	C ⁰	O	N	N	C	S	S	N	N	N	O	O	S	O	N	O	O
Earthquakes	N	C ¹	O			C	O	O	N	N	P	O	O	P	O	O	C	O
Forest fires	S	N	N	O	O	S	O	S	N	O	O	O	O	S	O	N	S	N
Volcanic eruption	N	N	O			C	O	O	N	N	P	O	O	P	O			N
Lightning	O	O	O		O	O	O	O	O	O	O			O	O		O	O

1 for simple retail risks only

2 only if hail results from a storm

Type of insurance cover

C = Compulsory cover by law

P = Obligatory pool

O = Optional cover

S = Cover offered but not widely taken

N = Non-existent

Rate of penetration of cover

■ = > 75%

■ = 25-75%

■ = 10-25%

■ = < 10%

□ = not known

Source: CEA, 2009.

2.2 What Flood Insurance Products do Exist?

While mainly descriptive and illustrative, existing overviews provide an outline of the wide range of different types of insurance schemes in operation — ranging from private market solutions to publicly funded risk pools, including compulsory schemes and completely voluntary offerings (CCS, 2008; CEA, 2009).

The products through which flood risk can be transferred also differ according to what they cover and who the insured are:

- *property insurance* for homeowners, businesses, and public entities;
- *sovereign disaster risk transfer* aims to increase the financial response capacity of governments in the aftermath of natural disasters. This protects their long-term fiscal balances through insurance or insurance-linked securities (e.g., catastrophe bonds, catastrophe swaps, and weather hedges);
- *agricultural insurance cover* for farmers, herders, and agricultural financing institutions for losses arising from adverse natural hazards, provided as either “index-based” or “indemnity-based”;
- *natural disaster micro-insurance aimed* protecting the livelihoods of the poor against natural hazard events;
- *business interruption* covering loss of income during the time that normal operation cannot be continued; and finally
- *reinsurance* for a portion or all of a risk portfolio from an insurer to spread the risk and protect solvency.

Flood insurance schemes in high-income countries are mostly aimed at property risks as well as agriculture, with the majority of losses in developed markets arising from property and business interruption losses (Mills, 2005). For low and medium income economies the ClimateWise Compendium shows that agricultural insurance is the most common type in all income categories. Traditional indemnity-based schemes are the dominant type in upper-middle income countries, and newer index-based schemes have a larger share in low- and lower middle-income countries. This could be related to the fact that schemes in those two income groups have only emerged recently and are often specifically designed to test the use of index-based risk transfer as a way to overcome enormous transaction costs, adverse selection, and moral hazard (Murphy *et al.*, 2011). Nevertheless concerns about addressing basis risk, remain (Government Office for Science, 2010; Linnerooth-Bayer and Mechler, 2009). Disaster micro-insurance is common in low-income and lower middle-income countries, but property catastrophe insurance schemes are almost absent from these countries (Surminski and Oramas-Dorta, 2011).

2.3 Is Flood Insurance Mandatory or Bought on a Voluntary Basis?

In most countries, flood insurance is purchased on a voluntary basis, although homeowners and farmers may be required to take up insurance

as part of mortgage and loan requirements. Some countries have a mandatory component, such as Spain, Belgium, and France⁶ (Botzen and van den Bergh, 2009; Paudel *et al.*, 2012) [see Table 1], while in developing countries some contract farmers are required to take out insurance (Surminski and Oramas-Dorta, 2013).

2.4 Is Flood Insurance Provided by the Private Sector or by the State?

The provision of flood insurance ranges from completely private market solutions to state-provided schemes. Within this range there are a variety of schemes, in many cases based on a degree of public–private partnership. Business insurance is usually provided by the private market, while public involvement in the provision of residential flood insurance is very common, with many countries applying some form of public–private arrangement (Aakre *et al.*, 2010; Bruggeman *et al.*, 2010; Paudel *et al.*, 2012; Schwarze *et al.*, 2011). One example of a state-managed insurance scheme is the French CatNat (Catastrophes Naturelles) system, a natural catastrophe coverage scheme, administered through private intermediaries (GFDRR, 2012, Chapter 8; Paudel *et al.*, 2012). Other schemes purely underwritten by the public sector are the public cantonal property insurers (KGVs) for weather related hazard damages in Switzerland (Schwarze *et al.*, 2011) or Spain’s Consorcio de Compensación de Seguros, a state monopoly (CCS, 2008). However, for most schemes there is a certain degree of private sector involvement. The role of private insurers’ spans underwriting, premium collection, claims handling, risk assessment, and awareness raising, as well as risk management advice and lobbying for political and regulatory responses (Surminski and Oramas-Dorta, 2011; Paudel *et al.*, 2012).

In the United Kingdom the underwriting is provided by the private sector, while government maintains a role in terms of flood risk information and flood management — as outlined in the Statement of Principles (SoP) (ABI, 2008). This approach is now being reviewed and will change from 2015.

How the roles of public and private agents are split also differs widely across the spectrum. The role of the state can be limited to preserve fair competition and financial viability of the insurer. State interventions can also boost the market through backing of the private market (government

⁶ The mandatory component of each of these schemes relates to the purchase of flood insurance alongside other perils. In Spain and France flood insurance is compulsory when buying property insurance and in Belgium it is compulsory when fire insurance is purchased (Paudel *et al.*, 2012).

led reinsurance, investing in preventative measures or by compelling insurance) and by doing so expand the market. In addition there is the public role in flood risk management. Often widely regarded as a public function, flood risk management complements flood insurance as a risk management tool without which insurance may not function effectively. The United Kingdom's SoP approach, with private insurers underwriting and administering policies, relies on government commitment to public investment in flood defences. The new system, Flood Re, seems to have less emphasis on the role of public risk management (Surminski and Eldridge, 2014). This points towards sharing the financial burden of flooding perhaps rather than reducing losses.

For low and middle-income countries the ClimateWise Compendium on disaster risk transfer (ClimateWise, 2011a) differentiates between the risk transfer role and other roles, such as operational support functions. For the provision of the actual risk transfer for flood insurance the following picture emerges: the private sector is providing the actual risk transfer in 41% of schemes, with varying risk levels and volumes of insurance and reinsurance layers included in the different schemes. In the majority of cases where the public sector is involved in risk transfer, it does so in partnership with the private sector (52%). These partnerships between the public and private sectors dominate in the provision of risk transfer in the case of indemnity-based agricultural insurance schemes, property catastrophe insurance schemes, and sovereign schemes. For index-based agricultural insurance schemes, however, provision of risk transfer by the private sector is more frequent. There is no exclusive public provision of index insurance by the public sector for schemes covering flood. For micro-insurance schemes, the three models are equally present. The role of the third sector in the provision of risk transfer is comparatively small (Surminski and Oramas-Dorta, 2011). Private sector capacity does not currently appear to be a limitation (Dizard, 2014), particularly at European level (Swiss Re, 2013).

2.5 What are the Operational Characteristics of Flood Insurance?

The existing flood insurance schemes differ significantly in terms of aim, approach, and functionality. The French Cat Nat aims to increase affordability, reduce adverse selection, and offers low priced public reinsurance covering several hazards including flooding. Funding is through a flat rate surcharge (6–12%) over existing policies against property damages (Botzen and van den Bergh, 2008; Poussin *et al.*, 2013).

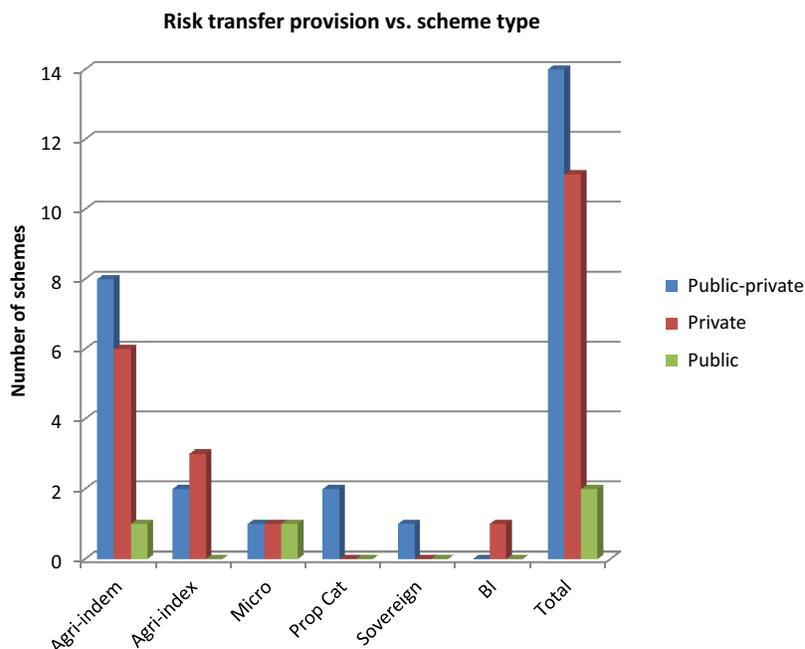


Figure 1. Number of flood insurance schemes by scheme type and public-private involvement.

Source: Surminski and Oramas-Dorta (2013).

The Spanish Insurance Compensation Consortium (CCS) scheme is an example of a solidaristic approach to provision of flood insurance. Flood insurance is granted on a subsidiary basis, through a flat rate surcharge if damages are not covered by private insurance. A deductible over public compensation applies with private insurance offered in a bundled system (ICC, 2014). Bundling, when used to insure against selected risks, makes certain other risks compulsory, as in the case of flood insurance and vice versa.

Not only does bundling increase market penetration but also reduces adverse selection and can encourage DRR through risk based pricing. However, it can result in unaffordable or inequitable premiums burdening schemes such as the CCS (Sugarman, 2006), raising issues including deductibles, co-insurance and caps (Sugarman, 2006).

Voluntary flood insurance schemes include those in Sweden and Portugal. Issued and managed through private insurers, policies are not backed by the

state. Risk based pricing is applied only in Portugal, while in Sweden the location of the asset does not influence the premium to be paid (Maccaferri *et al.*, 2012). Pricing in these cases seems not be the influencing factor in determining penetration rate, with mortgage lenders requiring borrowers to insure buildings in Sweden, resulting in high penetration rates above 90% (Maccaferri *et al.*, 2012). In contrast, Portugal does not follow this requirement and rates are much lower at 50%.

The US National Flood Insurance Programme is perhaps one of the most widely known state funded flood insurance schemes. Covering properties in areas where adequate floodplain management regulations are in place, with compulsory coverage for those with federally backed mortgages in the 1 in 100 flood zone, the scheme is administered by private insurers and can only be taken up by participating communities (Paudel *et al.*, 2012). Recently with reforms to address the programme's debt (built up after Hurricane Katrina), the provision of policies has moved significantly towards risk based pricing (GAO, 2013).

3 What Explains the Current Set-Up?

A growing body of literature analyses and explains the use and design of flood insurance. At an aggregate level, disparities in insurance penetration across countries can be explained in the context of income levels — as shown by the S-shaped relationship, referred to as the S-curve model,⁷ between insurance penetration and GDP (Carter and Dickinson, 1992; Enz, 2000; Outreville, 2011). Yet, the importance of effective and sound institutions for a well-functioning insurance market are clear and several studies have underlined the need for certain elements to be in place to drive the development of insurance. For example, the availability of risk data (Brainard, 2008), education and financial literacy levels play a key role (Masci *et al.*, 2007) as well as characteristics of the market such as distribution channels and the drive for innovative products and services (UNCTAD, 2004). Customs and traditions also play a part in explaining the different coverage levels that exist across countries (see Feyen *et al.*, 2011 and Hussels *et al.*, 2005 for reviews).

⁷ The S-curve is useful for long-term forecasting but as Enz (2000) states, it is only a one factor model as it only uses real GDP per capita and neglects all other factors that influence the demand for insurance — with some countries continually deviating from the curve (Enz, 2000).

This helps to understand some of the disparities — for example, between developed and developing countries at an aggregate level. However, explanations for specific lines of insurance, such as flood insurance, require a more nuanced analysis.

Research exploring flood insurance is a relatively small, but evolving field. A recent Scopus search found 71 articles focused on Flood Insurance⁸ and 54 articles exploring Natural Disaster Insurance.⁹ Most of the existing work on flood insurance is applied rather than theoretical, and evolves around specific flood insurance schemes:

Recent work investigating the United States National Flood Insurance Programme (NFIP) includes Knowles and Kunreuther (2014), Dehring and Halek (2013), Michel-Kerjan *et al.* (2012), Thomas and Leichenko (2011), Casadonte and Nevius (2012), Dixon *et al.* (2006), and Aerts and Botzen (2011a).

The situation in Germany has recently been investigated by Seifert *et al.* (2013), Zahn and Neuss (2011) and Keskitalo *et al.*, (2014).

Two examples for the Netherlands are Jongman *et al.* (2014) and Botzen and van den Bergh (2008). Recent work investigating the flood insurance provision in the United Kingdom includes Ball *et al.* (2013), Stallworthy (2013), Penning-Rowsell *et al.* (2014), and Surminski and Eldridge (2014). Flood insurance in the context of developing countries is receiving growing attention, as the work from Ranger *et al.* (2011a), Lin *et al.* (2007), Linnerooth-Bayer *et al.* (2011) and Surminski and Oramas-Dorta (2013) show. Some studies are interested in legal aspects (Morgan and Stallworthy, 2012) and governance (Paudel *et al.*, 2012) of flood insurance schemes.

The lenses applied to flood insurance by researchers can be broadly split by disciplines: the majority of papers explore it in an economic context, routed in the economics of risk and uncertainty and in financial theory. This also includes political economy and insurance economics with research into financial aspects such as scheme design and type of risk transfer, but also work on behaviour issues, moral hazard and adverse selection. While differing in approach and method, these existing strands of literature all seek

⁸ This search is conducted for any mentions of ‘flood insurance’ in the title of articles on Scopus. For a search of ‘flood insurance’ in titles, abstract, and keywords of articles gives a return of 490 articles.

⁹ Scopus search, title only, for ‘disaster insurance’ returns 54 articles, for ‘natural disaster insurance’, 23 articles are returned. Expanding this to include the title, abstract and keyword returns 869 and 390, respectively.

to increase understanding of at least one of the following three areas: supply, demand and design. A fourth aspect that appears to receive growing attention is rather cross-cutting: the roles of public and private sectors in flood insurance provision. The following sections illustrate the current state of knowledge for these four areas. In an attempt to capture the broad spectrum of flood insurance research this review is structured around a set of questions, collected in discussions with policy makers, industry representatives, and academics (Surminski *et al.*, 2014).

3.1 Demand: Why do Some People Buy Flood Insurance and Others do not?

The decision to buy insurance is an example of economic decision making under uncertainty. In the most simple model this decision is driven by income, price, and attitude towards risk (Schlesinger, 2013). The literature offers a range of other factors, deemed to play a role in influencing the decision to buy insurance, although empirical evidence for this is somewhat limited. Table 2 summarizes these ‘beyond income’ drivers for non-life insurance.

While most of these determinants help to explain general levels of insurance penetration, such as income, stable legal frameworks or financial literacy, there are also some factors that are deemed to be relevant specifically for flood insurance:

- Mandatory flood insurance, such as in Norway or Iceland, usually leads to high penetration rates (Bouwer *et al.*, 2007; CCS, 2008; OECD, 2003).
- Perception of other available financing (Raschky *et al.*, 2013).

For natural disasters the ‘risk factors’ are particularly relevant. Here a range of studies have explored individual decisions to buy disaster insurance. At the level of the consumer, researchers have focused on both the economically significant determinants of demand, as well as, psychological factors impacting consumer decision making. Browne and Hoyt (2000) list several reasons behind this including; (1) adverse selection¹⁰ (Akerlof, 1970; Lin, 2013) (2) underestimating tail probabilities (Kunreuther, 1984) and (3) expectation

¹⁰ Adverse selection occurs when those at increased risk have a greater demand for insurance with the insurer unaware of this relationship. To counteract such occurrences increasing premiums and limiting coverage to protect from large claims are strategies often used by insurers. For more information on adverse selection please see Akerlof (1970) and Lin (2013).

Table 2. Drivers of non-life insurance demand beyond income (from Ranger and Surminski, 2013).

Group of Drivers	Examples
Macroeconomic factors	Economic stability Low inflation rates Developed and stable financial markets Openness to trade
Political, regulatory and legal factors (including pre-conditions for insurance)	Stable legal and institutional frameworks Adequate insurance law Opening distribution channels (e.g. bancassurance) Conducive regulatory environment Property rights Judicial efficiency and transparency Mandatory insurance lines
Socio-cultural factors	Education Financial literacy Religious and cultural attitudes to risk and insurance Perception of other available financing in the event of a loss, such as disaster aid
Risk factors	The nature of exposure, such as the number of cars Natural catastrophe exposure Risk awareness linked with recent catastrophe experience

Source: Brainard, 2008; Feyen *et al.*, 2011, Hussels *et al.*, 2005; Swiss Re, 2004; USAID, 2006.

that some other entity will pay for any damages to property or livelihood, termed ‘charity hazard’ (Browne and Hoyt, 2000).

Further demand determinants include land assets owned (Sai *et al.*, 2010), how individuals’ decisions are affected by what others are doing in the local area to mitigate risk (Luffman, 2010) and relative tax differentials on insurance policies (Barker and Tooth, 2007). Behaviour economists have explored this, with Kunreuther and Pauly (2005) providing a very detailed review of anomalies in consumer purchasing decisions of insurance, the biggest being that even when insurance is heavily subsidised, individuals still do not buy it. This effect is even more perplexing when considering that many people who have insurance do not need it in strict economic terms (Kunreuther and Pauly, 2005). Two particularly relevant psychological factors

determining insurance purchases are risk aversion (Rabin and Thaler, 2001) and ambiguity aversion (Cabantous, 2007). Early economic research found that besides risk, individuals dislike ambiguous decision-making situations (Ellsberg, 1961). This effect impacts not only those who purchase insurance, but also those who underwrite it (Cabantous, 2007).

For developing countries, there are a range of additional challenges on the demand side, as highlighted by the growing literature about index-insurance, which investigates how best to overcome those demand issues such as insufficient understanding of the product, the lack of experience with insurance in general, and high prices (Cole *et al.*, 2009; Hoff *et al.*, 2005; Warner *et al.*, 2009).

3.2 Supply: What are the Challenges Facing Those Offering Flood Insurance?

The key consideration for private companies providing flood cover is to match costs (including expected losses, expenses for risk assessment, product development, marketing, operating, and claims processing) and (in the case of private insurance) revenue with premium levels, unless it is seen as a strategy investment to open up new markets or a pure PR or charity based activity (Charpentier, 2008; Kunreuther *et al.*, 2009). The decision to offer coverage can be influenced by the loss experience, regulatory requirements and the overall market conditions. Born and Klimaszewski-Blettner (2013) investigate the impact of natural disaster losses and regulation on the supply decisions of property insurers in the United States. Their empirical evidence suggests that home insurers are more likely to reduce their cover supply in response to unexpected severe events, while business insurers appear less likely to change their coverage in response to changes in severity or frequency of loss events (Born and Klimaszewski-Blettner, 2013). No similar research has been conducted in markets across the EU, but it is obvious that after a flood event, for instance, private insurers review their market position, pricing and coverage offers — which may trigger a re-assessment of the way flood insurance is provided, as currently seen in the United Kingdom.

At the same time the capacity of the insurance and reinsurance sector to provide coverage is driven by a wide range of other factors, including interest rates, regulation, overall market conditions and investment flows into the insurance sector (Cummins and Mahul, 2009). There are several factors that make the provision of natural disaster insurance at an affordable

price challenging: it is difficult to estimate uncertain extreme events; in many areas risk information is still very limited; and losses are volatile (Biener and Eling, 2011). This can be classified under (1) information asymmetries¹¹ and (2) insurability issues.¹² Both of these problems are intertwined: information asymmetries, such as adverse selection, can threaten the economic viability of the program, due to gaps between premiums received and claims paid (Huber, 2011). Particularly for developing countries there are significant supply side challenges for the provision of disaster insurance, such as high transaction costs and inadequate distribution channels, as well as limited availability of data and modelling tools, as presented by Ibarra and Skees (2007) and Suarez and Linnerooth-Bayer (2011).

3.3 *What Explains the Range of Public and Private Sector Schemes?*

The way how flood insurance is provided differs widely across the world, also with regards to the roles of the public and private sector. Supply and demand challenges have led to a range of approaches, with both sides taking on different roles and responsibilities. One strand of literature considers this in the context of ‘market failure’: on pure economic terms the public sector gets involved when flood insurance is not adequately provided by the private market [for example in the case of the US NFIP (GAO, 2013, p. 4; Sugarman, 2006)]. The term ‘adequately’ points towards the normative side of this aspect: the market failure can be subject to interpretation. Some see affordability as a key indicator (with unaffordability justifying public intervention), in a similar context as consumer protection justifies regulation of private insurers (Mills, 2005). However, others see lack of demand as a key justification for public intervention (Sugarman, 2006), while in other cases the aim of solidarity seems to be seen as the key driver for public involvement in flood insurance (O’Neill and O’Neill, 2012).

It remains unclear whether private or public insurance provision is more effective. In the absence of a best practice template Paudel *et al.* (2012)

¹¹ Information asymmetries describe when one member of a party has an advantage over the other through increased or a different understanding of the information available. In the case of insurance this can lead to issues of moral hazard and adverse selection.

¹² Insurability issues refer to a number of different factors resulting in difficulties in transferring a particular risk. These can include the costs of insuring, limited data availability, a lack of adequate modelling tools, as well as traditions and norms of dealing with risk in particular countries, for example, government assistance which can reduce the uptake of insurance (see Dionne, 2000).

propose a greater focus on public–private partnerships, where the government and private insurers share the provision of underwriting. The term partnership is very broadly used, but has its roots in efforts to increase the efficiency of public service by engaging the private sector. What is less clear are the rules of these partnerships and how they can deal with changing risk levels. This is investigated in Section 4.1.

The role of the state as an insurer of last resort is also an important consideration. Governments are expected to be increasingly called upon to address the impacts of climate and natural disasters. This can apply to the wider role of government as an overseer of risk management and may include actions such as clean-up post disaster or to meet the needs for adaptation, which were either foreseeable (e.g., long slow drought) or preventable (e.g., hurricanes). If markets are unattractive or the risks cannot be managed effectively then the burden may shift towards government and individuals to do so (Mills, 2005). In fact this may stimulate government action to develop new approaches to insurance arrangements (Botzen and van den Bergh, 2008), for example, public–private partnerships. Also if the stability of financial markets is threatened then the government may step in to secure continuing cover (Dobes *et al.*, 2013). At the same time, policy makers aim for greater engagement of the private sector with a view to achieve higher efficiency and to support insurance sector growth through the application of a market based mechanism. This reflects on a wider trend in the governance of natural disasters and climate risks towards more engagement of multiple actors, networks, and partnerships, the appearance of multilevel governance and shifts of responsibility away from the state (Walker *et al.*, 2010). Often this clashes with the duty to protect consumers and shelter voters from insurance price rises. This highlights the normative dimension of this issue, particularly with regards to the question of how to distribute the cost of losses: Here fundamentally different perspectives exists, such as solidarity versus risk-based pricing; or tax payer versus insurance holders.

The current flood insurance arrangement in the United Kingdom can be seen as such a ‘partnership’, a joint approach with roles and responsibilities divided between government and insurance. But as the current discussion shows, the roles may change. Insurers have been calling for government intervention in the form of Flood Re, which is proposed as a not-for-profit scheme, run by the private market and funded through a levy on all policy holders. During the public consultation phase the Government also presented three alternative options to Flood Re. While an imposed ‘obligation’ for insurers

to cover high risks remains the official ‘Plan B’ should Flood Re not deliver, the other two options have been dismissed by government and industry: free-market because of the unclear effect on premium levels and direct subsidy for high risk properties on the ground of being less beneficial than Flood Re due to potentially placing unsustainable costs on policyholders or the taxpayer (Defra, 2013a; Surminski and Eldridge, 2014).

3.4 Why is Designing a Flood Insurance Policy Often a Highly Political Undertaking?

There are a range of political motivations at play when considering introduction or reform of flood insurance schemes, showing that the pendulum of political support can swing in many directions (see for example Schwarze and Wagner (2007) for an analysis of the German natural hazard insurance market). On the one hand there is the aim of reducing current public expenditure for flood losses, while at the same time there are political considerations such as the need to maintain a visible ‘helping hand’ function after a disaster. This is particularly relevant in the run-up to elections, as an elected official may deliberately not choose to increase spending and hence raise taxes within their elected period, particularly when no clear benefits are visible during this time.

The current debate in the United Kingdom highlights the challenges with the existing flood insurance agreement, the SoP recently coming to an end (30 June 2013) and the move towards a new flood insurance scheme, termed Flood Re (due Summer, 2015). This change is principally due to the need to address rising losses. At the start of the negotiations a set of principles were published by the government (Box 1) outlining the vision for flood insurance.

Achieving all of these aims is proving extremely difficult. The proposed Flood Re, takes principles 1, 3 and 8 at its core and aims to ‘ensure the availability and affordability of flood insurance, without placing unsustainable costs on wider policyholders and the taxpayer’ (Defra, 2013a). However, the ‘value for money’ aspect of this is highly debatable as the scheme does not meet the minimum government standard for cost-benefits (Defra, 2013a, p. 30; 2013b), while the sustainability in the long run is questionable, as risk reduction measures are almost absent from the scheme. See also Section 4.2. (Surminski and Eldridge, 2013).

- Principles**
1. Insurance cover for flooding should be widely available.
 2. Flood insurance premiums and excesses should reflect the risk of flood damage to the property insured, taking into account any resistance or resilience measures.
 3. The provision of flood insurance should be equitable.
 4. The model should not distort competition between insurance firms.
 5. Any new model should be practical and deliverable.
 6. Any new model should encourage the take up of flood insurance, especially by low-income households.
 7. Where economically viable, affordable and technically possible, investment in flood risk management activity, including resilience and other measures to reduce flood risk, should be encouraged. This includes, but is not limited to, direct Government investment.
 8. Any new model should be sustainable in the long run, affordable to the public purse and offer value for money to the taxpayer.

Box 1. Principles for flood insurance, *Source:* Defra (2011, p. 5).

The underlying risk information can also become a topic for political debate, particularly if it has implications on the price of insurance. An example is the debate about windstorm insurance in Florida: A hurricane risk model developed to support insurance decisions in Florida was not licensed by the insurance regulator as modellers proposed to break with the tradition of averaging hurricane losses over the long term by giving more weight to higher hurricane activity in recent years (Phelan *et al.*, 2011), which would have led to higher premiums. Also, decision on risk thresholds and coverage limits can be subject to political negotiations between decision makers and stakeholders — as seen in the United Kingdom, where the current 75-year return period threshold for flood insurance in the United Kingdom was a compromise between industry and government.

4 The Challenge of Rising Flood Losses

The current public discourse about flood insurance is focused on two aspects: reforming existing insurance schemes, and developing insurance solutions where none exist. Examples for the first are the United Kingdom, Germany

and the United States, while efforts to introduce new schemes are visible not only in several developing countries, but also in more established markets, such as the Netherlands.

The objectives behind each flood insurance offering may differ across countries, but the underlying considerations are fairly similar and can be traced back to the pillars described in Section 3:

- Who pays and how much?
- What is the role of private insurers and the role of government?
- How does the scheme work in technical terms?

Finding answers to these questions requires political negotiations to determine regulation and pricing; an understanding of market behaviour and consumer choices; as well as technical know-how, including access to flood risk data and loss models. Flood insurance is often regarded as the most technically challenging type of insurance due to a lack of accurate assessment of exposure, difficulty in estimating the probability of occurrence of an event and potential losses faced (Botzen and van den Bergh, 2008; Swiss Re, 2012). In response, the industry has focused on improving the underlying risk data and their modelling capacity, often in close collaboration with public authorities. One example of this is the HORA initiative (see Stiefelmeyer and Hlatky, 2008), an Austrian public–private partnership (PPP) led by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and the Austrian Insurance Association (VVO). The collaboration seeks to provide the public with information for the self-assessment of risk through online mapping of risk zones for both flood (termed the HORA model), earthquake and hail. The key driver behind these efforts is a recognition that flood losses are increasing. In addition to the literature strands described above there is a more recent, slightly broader, sometimes multidisciplinary work on flood risk management emerging, where flood insurance is considered as one tool amongst others: evaluating the effectiveness of different flood risk management methods (Hansson *et al.*, 2008), or flood risk assessment where insurance is considered as a potential driver or mediating factor. Here a number of papers consider the implications of climate change (Botzen and van den Bergh, 2008; Filatova, 2013; Hochrainer-Stigler *et al.*, 2013), which will be explored in Section 4.1. Very limited work has focused on the prevention role of insurance in the context of flood risk.

4.1 Current and Future Loss-trends

Flooding across Europe from 2000 and 2012 resulted in average annual losses of €4.2 billion, this is expected to rise into the future with an estimate of €23.5 billion of loss by the year 2050, as compared to an average of €4 billion in 2010 (Jongman *et al.*, 2014). These growing losses are putting pressure on affordability and availability of flood insurance — a challenge that is expected to increase, due to socio-economic drivers and climate change.

Any assessment of climate change impacts needs to take into account both the physical aspects of a changing climate (hazard), and the socio-economic aspects that will determine the consequences that hazards can have. Recent work in this area has focussed on the linkages between different risk drivers, recognizing that climate change can exacerbate the risks arising from other trends such as urbanization and population growth (UNISDR, 2011). This has been investigated by a recent World Bank study into impacts of sea-level risk and storm surges for 393 cities in 31 developing countries. The report finds high asymmetries in terms of projected impacts, when taking into account population growth and economic development: “Our results suggest gross inequality in the heightened impact of future disasters, with 50% of the burden falling on the residents of 10 Asian cities and over 40% falling on Manila, Karachi, and Jakarta alone” (Brecht *et al.*, 2012).

Climate change has raised several questions regarding the role of insurance. Most research in this area has explored the impact that climate change could have on risk trends and risk patterns and what implications this may have for assessing risks and for the provision of future climate and natural disaster insurance (Botzen *et al.*, 2010; IPCC, 2014; Mills, 2009). A recent example is an investigation of the warming of the oceans and the implications that may result for the (re)insurance industry (The Geneva Association, 2013). Yet it remains unclear how climate change will feature in the risk profile. The risks and uncertainties arise not only directly from the physical impacts of climatic changes such as extreme weather events, natural disasters or slow-onset developments such as sea-level rise, but also indirectly from the political responses to these challenges.

The fine balance between affordability and profitability could therefore be affected by climate change, particularly if insurers fail to reflect on changing risk trends in their solvency arrangements, products or pricing regimes (Collier *et al.*, 2009). How they do this will not only depend on not

only regulatory policies, but also market conditions. Ranger and Surminski (2013) identify both positive and negative scenarios for insurance resulting from differences in policy responses to climate change, regulatory levels, company strategy, risk awareness and willingness-to-pay (Ranger and Surminski, 2013).

Theory and evidence from existing insurance markets suggests that a “riskier and more uncertain world would be associated with an increase in insurance demand, at least until some local threshold were reached where the affordability of insurance or the insurability of risk were threatened” (Ranger and Surminski, 2011).

However, the influence of climate change on insurance provision is expected to be multifaceted, complex and regionally variable. For those who provide insurance risk transfer, this creates not only new risks, but also opportunities. One such opportunity is presented by the Climate Corporation, a business that provides weather information and offers insurance to farmers. Offering data, modelling and weather simulations the Climate Corporation (2014) aims to ‘protect and improve’ farming operations. Coupled with insurance provision that automatically pays out in the event of a loss the scheme demonstrates the potential for more climate linked measures to aid knowledge, awareness and financial protection.

The insurance industry is often perceived as a conservative sector, with long traditions, slow innovation and little public visibility. However in the context of natural disaster risks and climate change, the industry has been surprisingly outspoken and played an increasingly public role over the last two decades. Some private insurance companies have explored the issue of climate change by collaborating with scientists, publicly engaging in policy debates, and also assessing the climate impacts on and opportunities for their own products (Mills, 2009). Individual companies as well as sector initiatives such as ClimateWise and UNEPFI’s Insurance Working Group, as well as industry organisations such as the Chartered Insurance Institute, the Geneva Association and national trade bodies, have started to publicly address this issue through statements and events. This public advocacy and outreach role has given the industry external visibility. In addition there is evidence of efforts led by the industry to improve risk information and knowledge: Several large reinsurers and insurers engage in public risk modelling exercises, sponsor research and science. Examples are HORA in Austria

(Stiefelmeyer and Hlatky, 2008), ZÜRS in Germany (Burghoff, 2012) and the engagement of the Association of British Insurers with public bodies such as the Environment Agency to improve the quality of flood maps in the United Kingdom (ABI, 2008).

There are signs that underwriting has become more technically oriented: applying sophisticated models and risk assessments, leading to risk-based approaches, but particularly with regards to residential risks and micro-insurance this often stands in contrast to the aim of ensuring affordability, and often faces regulatory barriers (Surminski *et al.*, 2014).

Beyond the activities in established markets there is also the quest for new growth markets (Guy Carpenter, 2012). Market players such as Lloyds of London warn of the growing underinsurance challenge (Lloyd's, 2012), identifying emerging markets as strategic growth targets. When entering these emerging markets, (re)insurers have to focus on their lack of understanding of natural catastrophes in these areas, the problems of pricing business correctly and monitoring exposure growth without suitable risk modelling tools. In many developing countries the data needed to underwrite flood risk is often not readily available, and there is no commercial case for private sector actors to develop such models on their own. This has led to an increased focus on public-private partnerships: ClimateWise, the industry-led climate initiative launched in 2008, points to the need for 'public-private partnerships' in order to exhaust the full potential of 'what is possible in building resilience to climate change impacts'. ClimateWise (2011b) refers to pilot projects and initiatives where its members are engaged and 'where national governments have come together with other relevant organisations such as private (re)insurers, non-governmental organisations and community groups to develop and implement new climate risk management and insurance partnerships'.

The Munich Climate Insurance Initiative (MCII), set up in April 2005 and particularly active at the UN level, promotes the use of insurance as a tool supported by both the private and public-private sectors, in the quest to develop new insurance solutions. The initiative suggests that such a partnership could 'offer the market sustainability of private sector approaches, and the flexibility and innovation of public sector approaches (and that) subsidiarity means that each partner will have clearly defined, distinct roles to play' (MCII, 2011).

4.2 *Physical Risk Reduction and Insurance*

One response to the concerns about rising risk levels could be a greater linkage between insurance risk transfer and physical risk reduction measures. This is based on the hypothesis that insurance can play a role in driving risk behaviour. The IPCC's report on managing the risk of extreme events (IPCC, 2012) concludes that 'risk sharing (formal insurance, micro-insurance, crop insurance) can be a tool for risk reduction and for recovering livelihoods' particularly in the face of extreme weather events, but warns that it could also provide disincentives, if not correctly structured. The key message emerging from this literature is that the design and implementation of a risk transfer scheme will determine the promotion of risk reduction and the level of moral hazard (Ranger *et al.*, 2011b).

In theory insurance can attach a price tag to risks and send a signal to agents such as policy holders, governments or insurers themselves, incentivising or even forcing them to address the underlying risk (see, for example, Kunreuther, 1996; Botzen *et al.*, 2009; Botzen and van den Bergh, 2009; Shilling *et al.*, 1989; Treby *et al.*, 2006). Insurance incentives are also stated to aid implementation of flood risk reduction measures (Botzen *et al.*, 2009; Camerer and Kunreuther, 1989; Crichton, 2008; Kunreuther, 1996; Kunreuther and Michel-Kerjan, 2009). When the premium is priced in line with the risk, insurance can act in two fundamental ways; for example, it can prevent settlement in an area of increased flood risk with the premium payment (as compared to a lower risk zone) expected to deter people away from such areas — this also has the additional benefit of not impacting on the wider community, such as the tax payer or other policy holders through ex post aid and subsidised premiums respectively (Filatova, 2013). Secondly, risk reflective pricing can encourage engagement with mitigation measures (Kunreuther and Michel-Kerjan, 2009), for example through insurance discounts once the measures are installed. There are many risk management options in different sectors that insurance may incentivize such as:

- Flood proofing of buildings and property,
- Retrofitting of houses (e.g., against windstorm),
- Local flood protection measures,
- Flood proofing infrastructure,
- Building larger scale flood protection schemes.

- Switching to more heat and drought resistance cultivars
- Implementation of more efficient irrigation measures
(from Bräuninger *et al.*, 2011)

Some recent studies have explored the link between flood risk reduction measures and premium pricing, through methods such as interviews with the insured, hypothetical modelling and willingness to pay exercises: Thieken *et al.* (2006) found that in Germany insured households are more likely to undertake risk reduction measures than uninsured, suggesting that flood insurance sets an incentive for policy holders to take action. For the Netherlands, Botzen *et al.* (2009) suggests that many homeowners would be willing to make investments in risk reduction if this would lead to an insurance premium reduction: ‘In particular, approximately two-thirds are willing to invest in water barriers (...) and about a fifth are willing to replace floor types that are vulnerable to flooding with water resistant floor types. Furthermore, about a quarter are willing to move central heating installations to floors safe against flooding’ (Botzen *et al.*, 2009).

But the practice shows that a range of factors prevent this from happening: the largest barrier is considered to be the absence of adequate risk-based pricing (Kunreuther, 1996) due to its conflict with affordability of cover, while the solidarity principle of insurance also hampers risk reflective pricing. But even if risk-based pricing would be applied Bräuninger *et al.* (2011) note several issues that would need to be addressed in order to achieve risk reduction: mis-match between required prevention investment by policy holders and the premium savings; the short term nature of insurance contracts; simplified rating structures used by insurers; as well as a prevailing uncertainty about the benefits of risk reduction measures- due to lack of standardised assessment methods, and the need for active involvement of policy holders to put in place and operate those mitigation measures (Bräuninger *et al.*, 2011). Other barriers to linking risk reduction and insurance exist and include limited institutional capacity, weak regulatory systems and insufficient understanding of the instruments amongst stakeholders (Suarez and Linnerooth-Bayer, 2011; Surminski and Oramas-Dorta, 2013).

In the context of linking risk reduction and risk transfer there is evidence of a range of activities conducted by the industry to foster prevention efforts. Surminski (2010) provides an illustration of how some insurers are engaged in risk reduction activities in the context of climate adaptation (Table 3).

Table 3. A range of case studies indicating the insurers involved, location and their adaptation focus.

Number	Title	Country	Adaptation focus
1	The Austrian Insurance Trade Association and HORA – the creation of a natural disaster zoning system	Austria	Promoting flood risk awareness through government partnership on flood risk data
2	Aviva's flood simulation exercise in Boroughbridge	UK	Facilitating community based flood resilience
3	RSA's Mayesbrook Park Restoration	UK	Supporting a pilot project to demonstrate community-level flood risk management
4	Insuring and managing flood risk - the Statement of Principles and the Association of British Insurers	UK	Partnering with government to achieve changes to the planning system, increased risk awareness and more investment in flood risk management measures
5	Royal Star Assurance's Digital Aerial Mapping	Bahamas/Cayman	Changing the approach to assessing and pricing wind storm risk
6	RMS's analysis of the Windstorm Mitigation Credit system in Florida	Florida, USA	Incentivising wind-storm risk reduction measures through a regulator-driven premium discount scheme
7	Caravan protection from hail storm by Allianz	Germany	Reducing hail-losses through a broker-led prevention initiative, funded through climate change mitigation
8	Insurance Research Lab for Better Homes in Canada – The Three Little Pigs Project	Canada	Promoting weather-resilience through industry led research
9	The Insurance Council of Australia's work on community resilience	Australia	Promoting windstorm and bush fire risk management by clarifying roles and responsibilities of different stakeholders
10	Swiss Re's research on the 'Economics of Climate Adaptation'	Global	Guidance and assistance to political decision makers on climate resilience

Source: Surminski (2010).

The initiatives identified are all based in established insurance markets. They include raising awareness of disaster risks, promoting action by government, and supporting action by individuals through incentives, information, financial support and terms and conditions for policies.

Despite these initiatives, it remains unclear to what extent they are effective and how they could be scaled up if deemed a success. For example the terms and conditions of an insurance policy, such as deductibles and

exclusions, are widely used to manage risks in commercial insurance and motor insurance, but are facing some limitations in property insurance. These aim not only to prevent moral hazard, but also seek to maintain the insurability of high risk properties. This is evident in the UK residential property market, where flood deductibles are being applied to homes that have been flooded several times (Grey and Pickard, 2013). But the effectiveness in reducing moral hazards in relation to residential natural catastrophe risks remains unclear. For example, a survey of 400 homeowners in the United Kingdom by Lamond *et al.* (2009) shows that insurers have been ineffective in encouraging their policyholders to adopt flood mitigation measures. As Ball *et al.* (2013) state the adoption of property level measures are difficult to assess so insurers do not necessarily see them as a basis for lowering policy costs. While there is evidence for risk information work conducted by the industry, providing online flood risk information and raising awareness with customers and government (ABI, 2012), this is not linked to the insurance policy documentation.

In the United States, the NFIP includes building code regulations and mitigation grant programmes as part of its requirements for cover (Paudel *et al.*, 2012; Thomas and Leichenko, 2011). This entitles policyholders who have gone beyond minimum requirements for building elevation to be eligible for premium discounts. It also applies to communities with adequate risk management plans, who can receive premium discounts for all those policyholders in the community by participating in Community Rating System. While in France deductibles can be increased for policyholders who live in communities that face repeated flooding and do not have adequate risk mitigation plans which include damage mitigation measures in place, while deductibles are lowered if such plans and risk reducing measures are taken (Poussin *et al.*, 2012). In developing countries there are also a few examples of direct operational link between risk transfer and risk reduction, for example: The Horn of Africa Risk Transfer for Adaptation (HARITA) program in Ethiopia and the Fondo de Mitigacion del Riesgo Agrario (FMRA) in Bolivia. How effective these mechanisms are is [“How effective these mechanisms are is difficult to measure, . . . ”] difficult to measure, particularly as some of them have only been running for a short time.

The case of flood insurance in the United Kingdom shows the absence of formal incentive mechanisms in the existing, and in the newly proposed Flood Re scheme. While rising flood losses and increasing costs of insurance are the two main reasons for reforming the existing insurance arrangements,

one important aspect has been widely neglected in the debate: how the existing arrangement and new flood insurance proposal reflect on the need to manage rising flood risks (Surminski and Eldridge, 2014).

One particular aspect to consider here is the case for long-term contracts, since long-term insurance may create incentives for homeowners to implement risk reducing measures, while there are also clearly limitations to the use of multi-year contracts (Maynard and Ranger, 2011). An assessment of long-term flood insurance contracts in the Netherlands finds that the pricing of such contracts is complicated because of the uncertain future effects of climate change on flood risks, which could result in mark ups of long-term insurance premiums (Aerts and Botzen, 2011a, b). However, a study of the demand for long-term insurance products has shown that consumers may have a higher willingness-to-pay for long-term flood insurance, than annual flood insurance because they prefer the price stability offered by long-term contracts (Botzen *et al.*, 2013). This understanding will require further analysis to determine how pricing and the potential for long-term insurance contracts continues into the future, particularly when the understanding of climate change and modelling accuracy is expected to evolve significantly in coming years.

Depending on design and implementation an insurance scheme can send signals to policy makers in support of flood risk management policies, which would address risk levels and provide political guidance. The clearest link would be a financial liability, which makes government responsible for paying certain losses above a loss threshold with an interest in keeping losses low. This concept is absent from the SoP scheme, and also from the proposed Flood Re. Throughout the negotiations between industry and government this appears to have been a critical aspect and there remains a lack of clarity about how catastrophic losses that might exhaust the pool would be dealt with.

The agreement from insurers to provide cover under the SoP is based on the expectation that government would deliver on their commitment of sufficient investment in flood defences and an improved public planning policy, outlined as clear indicators in the main SoP agreement document: As ‘action from government’ it lists ‘reducing the probability of flooding in the United Kingdom; at least maintaining investment in flood management each year and discuss future funding taking into account climate change, implement reforms to the land use planning system; communicate flood risk effectively and provide more detailed higher quality flood risk information and develop

an integrated approach to urban drainage' (ABI, 2005). While the fulfilment of these policy demands has been subject to debate — particularly with regards to investment levels, but also about the success of the planning system — it is a clear lever to steer public policy and government spending, particularly in times of public spending constraints.

5 Outlook

Flood insurance is a long-established economic tool in some countries, while non-existent in others. The literature offers a range of explanations for this 'patchwork' of flood insurance penetration based on the investigation of both the demand and supply side. This is reflected in the public discourse about affordability and availability of this type of insurance. However, there appears to be a significant gap in terms of understanding the implications of current and future flood risk trends for the offering of flood insurance. These trends are likely to pose a significant challenge for the financial compensation of flood losses, unless more preventative measures such as flood defence investment and stricter building codes are applied. Effective prevention is expected to play a significant role for future affordability and availability of flood insurance. However, it is far from clear how these two approaches interact, and where the scope for future reform is. Particularly the question of utilizing flood insurance as a lever for physical risk reduction would benefit from further empirical and theoretical analysis.

Risk transfer alone, without consideration of risk reduction efforts, is not a sustainable solution going forward, particularly in the context of a changing climate and rising flood losses. Moral hazard is a key challenge for any insurance product, as it can undermine the economic benefits of risk transfer and the wider efforts to reduce risks. While stakeholders have only limited direct control over the occurrence of a flood, their actions determine the extent of losses during and after the event. Therefore moral hazard can occur at government level, where the existence of an insurance scheme may reduce the urgency to prevent and reduce risks, or at the insured level, where the purchase of insurance may lead to a false sense of security. In theory risk-based pricing should help prevent moral hazard and promote risk reduction behaviour. Evidence of how this works in practice is limited. Due to affordability concerns this may have to be linked to public financial support measures at least on a temporary basis. There is evidence of a range of further

activities conducted by the insurance industry to foster disaster prevention efforts, but it remains unclear to what extent they are effective at household level and to what extent they could be scaled up if deemed a success. Other stakeholders may be needed to reflect on the risk reduction potential, such as property developers, home-builders and mortgage providers in the context of property insurance.

One important conclusion is to avoid the situation where risk reduction is seen as a trade-off with affordability and availability. Considering these aspects as mutually reinforcing seems to be a more sensible approach. One could argue that risk reduction efforts are essential in maintaining the insurability of these risks, especially in the context of flooding and other extreme weather events, and that effective adaptation may actually become a condition for granting insurance cover in the future.

However, there are also clear limitations: while some risks arising from flooding can be reduced through better preparedness, there will always be residual risks that can leave those exposed with significant financial gaps and increase poverty. What can insurance offer for those risks ‘beyond risk reduction’ — such as land-loss due to sea level rise? This is starting to be addressed as part of the Loss and Damage discourse within the international climate change negotiations (see UNFCCC, 2010, para. 25-29). Progress in these areas depends on more clarity on the limitations of insurance as a tool and insurance as a private sector offering. Progress in this area will depend on a mix of increased evidence and understanding of underlying risk issues, better collaboration of stakeholders and openness about limitations and costs. The issue spans many dimensions, which makes innovation and reform challenging for political decision makers and private companies: the suitability of insurance depends on the particular risks, political objectives and the design of a proposed scheme. Reforming existing schemes appears very challenging, as the case of the UK flood insurance system shows. This is why the discussions about new schemes in developing countries are so important. Here is a chance to avoid repeating those past mistakes in established markets, particularly regarding the missing link between risk transfer and risk reduction.

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