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D 5.3: NOVEL AND IMPROVED INSURANCE INSTRUMENTS FOR RISK REDUCTION





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Executive summary

Managing risk and adapting to climate change is essential to minimise the losses and damages during and after disasters and extreme weather events. Several risk management approaches exist, one of which is the use of economic instruments (EI). Examples of EIs include taxes, subsidies and insurance to deliver financial protection in the event of a disaster, yet their design and the way in which they operate is essential to their success in mitigating and minimising hazard loss. Insurance is one example of an EI and functions as a tool to share and transfer risks and losses and is useful in aiding adaptation to climate change. Within this context insurance may be delivered using a range of approaches, which together contribute to its feasibility for delivery and operation as well as the potential for incentivising behavioural change. Yet undesirable aspects also exist and can include a lack of comprehensive information and cognitive biases, as well as financial constraints and moral hazard.

This paper considers two key questions in the context of natural disaster insurance and risk reduction: How to assess existing insurance offerings and how to design new schemes? It brings together theoretical work, qualitative and quantitative approaches, and case-study evidence from across Europe under the ENHANCE project.

We introduce six different methodologies for assessing the linkages between insurance and risk reduction: Stress testing; investigation of flood insurance and moral hazard; estimation of effectiveness of household-level flood risk mitigation measures; assessment of risk based insurance pricing incentives for flood risk mitigation; analysis through a Risk Reduction Framework; and investigation of the design principles of insurance.

We then explore the applicability of those six methods for five different cases studies, in which insurance is either non-existing, proposed, or being reformed or revised: Multi-hazard risk assessment in Po River basin basins (Italy); Flood insurance in England (United Kingdom); Insurance and forest fire resilience in Chamusca (Portugal); Flood risk management for Critical infrastructure: Port of Rotterdam (The Netherlands); Disaster insurance in Romania and the EU Solidarity Fund.

Our analysis concludes with a discussion of how the six methods could assist the development of innovative responses to natural hazard risk management, particularly in a multi-sectoral partnership context.





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1 Insurance instruments and risk reduction: context, background, case studies

Insurance is one example of an Economic Instrument (EI), used alongside several approaches, including subsidies and taxes, to manage natural disaster risk and to adapt to climate change. Insurance is a widely used Risk Financing Instrument (RFI) that seeks to promote the sharing and transfer of risks and losses (see Chambwera et al., 2014; Bräuninger et al., 2011). As an RFI, insurance is characterised by being purchased by those at risk before an event and finances losses both during and after a disaster. Beyond the direct financial role that insurance plays, it may also have an additional purpose of incentivising and eliciting risk behaviour through certain prerequisite features, including for example, risk based pricing and provision of hazard information.

In the wake of rising losses and growing concerns about climate change this prevention role of insurance is receiving attention, including from policy makers: In 2013 the European Commission 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 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 prevention and disaster damage mitigation. The EC specifically asks in the consultation how risk transfer can reduce disaster risks today and into the future (Surminski, 2014).

Deliverable 5.1, the *'Review of economic instruments in risk reduction'*, identified types of EI and reviewed their scope for incentivising disaster risk management. It found that linkages to risk reduction could be categorized into three main approaches: directly, indirectly and through minimising systemic risk. Building on the findings of Deliverable 5.1, this working paper determines how one could assess the risk reduction linkages of insurance based on those case study examples.

Our investigation starts with the identification of the key variables that are required to facilitate an insurance scheme in both established and developing markets, including vulnerability reduction. Following on from this, we introduce several different approaches for assessing insurance, using both qualitative and quantitative methodologies. We explore the applicability of those different assessment methods in the context of five case studies from the ENHANCE project:

- **Multi-hazard risk assessment in Po River basin (Italy)**
Flooding and drought pose two major concerns in the Po River Basin and insurance schemes are in place for both hazards with each demonstrating elements of indirect risk reduction.
- **Flood risk and climate change implications for Multi Sector Partnerships (United Kingdom)**
Delivered by private insurers, the current all-encompassing scheme is due to change to a new pooled approach to cover only those households at highest risk with no financial





remit from the state. Some risk reduction elements are in place and the design of the new scheme is fundamental to its longevity.

- **Insurance and forest fire resilience in Chamusca (Portugal)**

Forest insurance is mandatory yet insurance products are scarce, in delivering insurance solutions, challenges are highlighted and the approaches of the four existing forest insurance schemes are detailed.

- **Flood risk management for Critical infrastructure (The Netherlands)**

Provision of flood risk management in a high risk area presents several challenges for effective application and an innovative multi stakeholder approach aims to deliver a reduction in societal risk.

- **Testing the Solidarity Fund for Romania and Eastern Europe**

Mandatory natural hazard insurance is required under law for residential properties in Romania yet includes no risk reduction elements, using a supranational fund such as the European Union Solidarity Fund could provide a link to potential ex ante capitalisation of disaster funding for risk reduction action.



2 Towards a new framework: identifying metrics

Evidence from natural disaster insurance schemes in established markets and developing countries shows that the overarching, guiding considerations are commercial viability, financial sustainability, and affordability. However, with the prospect of growing impacts from climatic risks due to climate change and socio-economic growth we have added ‘vulnerability reduction’ as a fourth variable to our investigation. Below we outline the range of metrics and interpretations that exists for each of those variables:

2.1 Demand and affordability

A key component for any insurance scheme is demand for this type of product from those at risk. Our research shows that a range of factors are at play when determining insurance demand, as shown in *Table 1* (below).

Table 1: 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

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

While these drivers (Table 1) are all wider determinants of demand, our evidence base suggests that the question of affordability is the key consideration when it comes to securing demand for a new or existing product. Kunreuther (2006) defines affordability as, “the financial ability of residents in hazard-prone areas to buy coverage (Kunreuther, 2006).” Linked to this is the question how much coverage does a given amount of premium buy. A useful metric is the ratio of the average premium paid versus the average coverage obtained in some given geographical area (Michel-Kerjan and Koursky, 2010; Michel-Kerjan, 2010). Understanding how this varies in relationship to risk levels, income and property values can give insight into how a consumer profile impacts the type of insurance received. This has been investigated for the Turkish Catastrophic Insurance Pool, which intends to provide risk based, but still affordable premiums. (Gurenko et al., 2006). Important in this context is the role of government subsidies to support affordability. (Mahul and Stutley, 2010).



2.2 Supply and commercial viability

The key consideration for those who provide risk transfer 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 public relations 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 homeowners' insurers are more likely to reduce their cover supply in response to unexpected severe events, while commercial lines 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 UK.

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 reasons 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, 2012). This can be classified under (1) information asymmetries¹ and (2) insurability issues². Both of these problems are intertwined, as 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).

Commercial viability has few explicit definitions. Hazell (1992) presents a definition of $(A+I)/P$, or the loss ratio, where A = administrative cost, I = indemnity payments and P = Premiums (Hazell, 1992). This has been used numerous times to assess commercial viability (Akter et al., 2007). This metric can also be used to assess financial sustainability, as a negative loss ratio represents a financially unsustainable insurance product. Others have suggested including the cost of risk bearing, or the opportunity cost of money held in reserve for future large scale loss events (Bardsley et al., 1984). Another metric is market penetration rates. This represents the percent of the eligible population who is purchasing a product. While this metric does not give a precise sense of the financial health of a policy, it does allow one to proxy how well a given product fits with the consumers it is targeting. Research

¹ 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.

² 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).



has shown vastly different penetration rates across European insurance markets (Swiss Re, 2013).

2.3 Financial sustainability and solvency

Defining financial sustainability seems somewhat clearer, mainly because of the regulatory focus on solvency. Insurance systems will have to accommodate the remit of Solvency II ensuring that schemes are economically risk secure. Solvency II determines the risk appetite as well as the internal risk portfolio decisions of insurance companies. It demands a structured risk-based approach to assess the solvency risks faced by insurance and reinsurance companies, including flood insurance (EC, 2009). It also regulates the assessment and validation of the methods being used to do so. If validated, evidence that these methods are actually followed should be provided (EC, 2009). Finally, it imposes an upper limit on the probability that the annual losses exceed company's operating capital (EC, 2009; Surminski et al. 2015). Solvency and financial sustainability revolve around accounting statements. Table 2 (see below) presents Meyer's (2002) definition used in the context of microfinance insurance products. What is defined as long term versus short term, Meyer (2002) defines as operational versus financial sustainability (Meyer, 2002). The long term versus short term distinction is more accurate for this paper, in that the only scenario for cost of funds subsidies to be withdrawn is if large reinsurers, be it private or public, go bankrupt, a problem that should be calculated into long term sustainability planning.

2.4 Vulnerability reduction

For vulnerability reduction, there are a series of reviews detailing the economic methodology used to assess the impacts of disasters (Kliesen and Mill, 1994; Cavallo and Noy, 2010; Hallegatte and Pryzyluski, 2010). Some examples are presented in Table 2. Those are primarily focused on how to reduce the ex-post impact of disasters. However, there can be many routes to reducing the vulnerability, such as focusing on equity issues.

Table 2: Variables and associated metrics of insurance.

Term	Definition	Metrics Used
Affordability	Cost effectiveness of an insurance product from the perspective of the consumer	<ul style="list-style-type: none"> • Average Premium Paid / Average Coverage Amount (Michel-Kerjan and Koursky, 2010; Michel-Kerjan, 2010) • Premium paid/expected insured losses
Commercial Viability	Demand of an insurance product to the particular market segment the product is designed for and the potential risk-adjusted profit	<ul style="list-style-type: none"> • (Administrative Cost + Indemnity Payments)/Premium Payments (Hazell, 1992) • Opportunity cost of money held in reserves (Bardsley et al., 1984) • Number of Insureds/Number of Eligible Persons (Swiss Re, 2013) • Potential revenues = (number of insured + number of potentially insured)



		<p>x average premium, including returns from investing accumulated premium in equity markets</p> <ul style="list-style-type: none"> • Potential costs: administrative + expected indemnity payments (claims) + cost of reserve capital and any losses from investments • Risks - insurance companies load the premiums to take account of risk (Froot, 1999; Mahul and Stutley, 2010)
Financial Sustainability³	<p>Short Term—Operating income is sufficient to cover operating costs, including salaries and wages, supplies, loan losses, and other administrative costs.</p> <p>Long Term—Operating income and capital is sufficient to cover costs of funds and other forms of subsidies received when they are valued at market rates(Definition from Meyer, 2002)⁴</p>	<ul style="list-style-type: none"> • (Administrative Cost + Indemnity Payments)/Premium Payments (Hazell, 1992) • (Administrative Cost + Indemnity Payments)/Non-Subsidized Premium Payments (Mahul and Stutley, 2010) • Claims paying capacity, including reinsurance limits, as well as, free capital (CCRIF, 2013) • Solvency ratios
Vulnerability Reduction	<p>Lessening the two types of impacts from disasters:</p> <p>1) Direct impacts are those resulting from building, lifeline, and infrastructure damages</p> <p>2) Indirect impacts are those that follow from the physical damages (Definition from Kliesen and Mill, 1994).</p>	<ul style="list-style-type: none"> • Change in individual wealth, physical and other assets, from disaster events (Kliessen and Mill, 1994) • Dollar value of indirect and direct impacts (Kliessen and Mill, 1994) • Percentage of total losses insured (Kliessen and Mill, 1994) • Number of people killed and/or affected (Cavallo and Noy, 2010) • Changes to macroeconomic indicators (Cavallo and Noy, 2010) • Number of risk reduction measures installed in households • Number of households moving out of high-risk areas

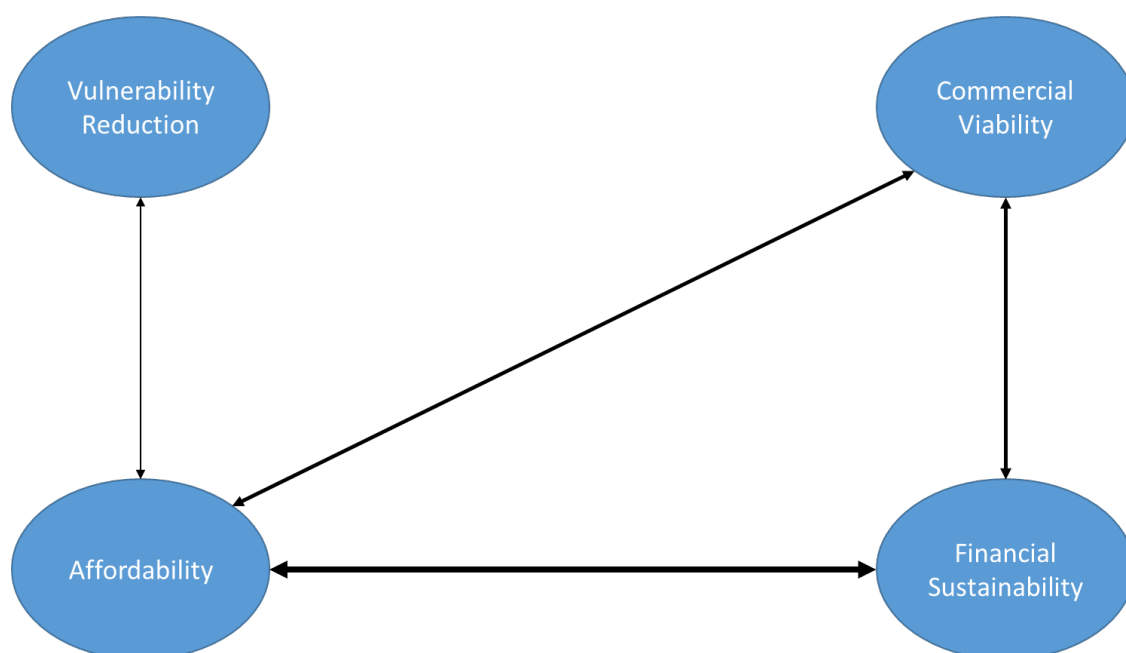
The relationships between affordability, financial sustainability, commercial viability, and vulnerability reduction do not receive equal treatment in the empirical literature. *Figure 1* provides a representation of the connections and amount of empirical investigation of these relationships, with the thicker the line connecting pairs of variables, the more those variables have been studied in the literature. As can be seen, the most studied are affordability and financial sustainability . This focus is due to these two issues being at the core when insurers design new insurance products (Akter et al., 2007). The other relationships appear to have been either studied less or not studied at all⁵.

³ Financial sustainability will also be driven by the investment income of insurers. However, in this report we focus on the underwriting operations of the industry.

⁵ A more detailed investigation of those relationships is currently underway and will be published separately.



Figure 1: Empirical investigation of relationships



When determining the relationship between these variables, it is important to recognize the role of government policy. Traditionally one looks at classical supply and demand questions surrounding insurance companies. Demand issues include willingness to pay and consumer risk profiles. Supply issues deal mainly with insurance budgetary decisions, such as amount of reinsurance purchased, prices to offer policies at, as well as, other internal firm budgetary decisions. Interacting with these economic effects are governmental efforts within the insurance market. It is nearly impossible to discuss any insurance market without considering governmental policies impacting it. For example, in many markets, the government is the sole reinsurer (Paudel et al., 2012), while in others it determines market rules, subsidises premium or sets prices.

The suitability of insurance depends on the particular risks, political objectives and the design of a proposed scheme. Insurance is provided publicly, privately, through a partnership, subsidized or mandated – guided either by the principle of solidarity or considered as a risk-based market mechanism. There are a range of political motivations at play when considering introduction or reform of natural disaster 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 natural disaster 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. Another common goal is the engagement of the private sector with a view to achieve greater efficiency and 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 (Gordon 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 exist, such as solidarity versus risk-based pricing; tax payer versus insurance holders. (Surminski 2015)

For our investigation we are particularly interested in the interplay between vulnerability reduction and the other three variables.

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 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 commercial viability 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 strongly depend on regulatory policies, but also market conditions. Ranger and Surminski (2013) identify 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).

The rising risk trends are likely to pose a significant challenge for insurance (e.g. Paudel et al. 2014), unless more risk reducing measures are applied, such as flood defences, stricter building codes and/or land use (zoning) policies. Effective prevention is expected to play a significant role for affordability and availability of loss compensation mechanisms (Kunreuther, 1996), but it is far from clear how these two approaches interact, and where the scope for future reform is. 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, 2013).



There is ample evidence that insurance, or risk transfer in general, can boost resilience to natural hazards more (effectively) than ex-post disaster aid (e.g. Ranger et al., 2011). Insurance can reduce financial burdens and uncertainty (Ghesquiere and Mahul, 2007; Melecky and Raddatz, 2011), and assists economies in dealing with the negative long run impacts of natural hazards such as flooding (von Peter et al., 2012). Risk pricing may encourage the reduction of exposure and lead to lower damage costs (Bozzola, 2014; Kunreuther, 1996;). Yet on the other hand poorly designed insurance products and ill-structured insurance markets can drive economic inefficiency and maladaptation to future risks (Michel-Kerjan, 2010; Surminski, 2013).

In the following section we introduce six different methods for investigating the insurance-risk reduction linkages.



3 Methodologies for assessing insurance and risk reduction

3.1 Stress testing

The core method of the stress testing is the development and use of aggregated probabilistic flood damage models, as presented in Jongman et al. (2014), for national and trans-national flood risk assessments. Probabilistic models represent a methodological advancement due to how previous methods have estimated flood risk. The first advancement comes from the observation that there are interdependencies across river basins. These interdependencies result in flood occurrence probabilities that are not independent of one another. So far, little is known about such flood hazard interdependencies across regions (Uhlemann, 2010; Prudhomme and Genevier, 2011) and these interdependencies can lead to large trans-national impacts. The approach taken by Jongman et al. (2014) both estimates and integrates these interdependencies into an EU river basin wide flood damage model. The second advancement is that at the national level an aggregate loss value with an occurrence probability of 1% a year could be the result of a large number of small flood events or a single major event across river basins, which is not often considered in such models. Reliable information on correlated loss probabilities is crucial for developing robust insurance schemes and public adaptation funds (Mills, 2005; cited in Jongman et al., 2014). Jongman et al. (2014) provide information on correlated loss probabilities by estimating flood damage distributions for 1,007 river basins across Europe, which are then aggregated using copulas into national and then into a transnational distribution. Aggregating flood damage distributions in this manner allows for the damage distribution to be understood as the product of a wide range of possible flood events.

The Jongman et al. (2014) method is directly connected to the ENHANCE case study regarding the European Solidarity Fund (EUSF) as the trans-national flood damage distribution forms the base of a EUSF stress test. The stress test is conducted by investigating the insolvency probability of the European Solidarity Fund prior to the EUSF reform. Jongman et al. (2014) estimate that by 2050 the fund's insolvency probability will be 80% larger compared to 2013, due to the combined effects of climate and socio-economic growth under the SERSA1B climate change scenario. Moreover, an indirect stress test of national insurance schemes is also conducted by investigating the value of capital required in total across the EU to remain solvent according to Solvency II. The indirect stress test was conducted by estimating the losses corresponding to the 99.9th quantile over 2000-2050, which corresponds to the Solvency II requirements. Jongman et al. (2014) estimate that by 2050 the solvency capital reserves required for flood risk will be doubled compared to 2013, under the same scenario mentioned above.

3.2 Investigation of flood insurance and moral hazard

Hudson et al. (2014a) report that it is commonly believed that moral hazard can cause market failures in natural hazard insurance markets. The presence of moral hazard in an insurance market will tend to place greater pressures on the insurance industry. This is, theoretically, because the households with insurance are disincentivised from undertaking damage mitigation measures because the financial impact of a hazard event is reduced by insurance



reimbursements. However, such problems may not arise if individuals mainly buy insurance based on risk preferences, which means that the highly risk averse buy insurance and seek to reduce the risk that they face. This, potentially, allows for advantageous selection to occur. Whereby, insurance provokes a positive (or at least neutral) behavioural response to holding an insurance policy. The methodology used in Hudson et al. (2014a) extends the statistical toolbox used for investigating the presence of moral hazard in an insurance market. Hudson et al. (2014a) apply both a series of univariate and bivariate probit models, which is a common approach to examine moral hazard (e.g. Chiappori and Salanie, 2000; Cutler et al., 2008). The probit model approach seeks to investigate the presence of information asymmetries insurers and policyholders and to what extent the behaviour of policyholders can be connected to differences in risk preferences. In this sense advantageous selection would be present if insurance purchase is strongly connected to traits that reduce risk. Hudson et al. (2014a) additionally use Propensity Score Matching and Heckman Sample selection models as tools for investigating the presence of insurance related behavioural changes. Propensity Score Matching is a methodology developed for evaluating treatment effects estimated from observational studies rather than experimental studies. Propensity Score Matching estimates an unbiased treatment effect of a household holding an insurance policy on the damage suffered during a flood, which can be viewed as the extra pressure, on average, that moral hazard places on risk-financing mechanisms. Moreover, the bias treatment effect could be seen as an estimate of adverse selection by examining to what extent higher damages by insured households are due to more severe flood hazard conditions faced by the insured. The statistical analyses in Hudson et al. (2014a) are based on survey data of individual disaster insurance purchases and risk mitigation activities in Germany and the United States. Consistent results are obtained in both countries supporting advantageous selection. In particular, it was found that insured individuals take more damage mitigation measures than uninsured individuals, and there is no evidence that a moral hazard effect increased observed flood damages in the past. This has significant potential public policy relevance regarding the effectiveness of their respective existing market structures for natural disaster insurance as the study indicates that moral hazard may not be present. The finding that the moral hazard is not detected across two culturally different countries, different natural hazards, and differing market structures generated a general and robust finding.

3.3 Estimation of effectiveness of household-level flood risk mitigation measures

There is a large literature arguing that flood insurance companies should stimulate policyholder investments in damage mitigation measures, e.g. Kunreuther (1996), Botzen et al., (2009a). However, only a small number of studies detail the effectiveness of such measures and how much flood damage they potentially minimise, for example, see deMoel et al. (2013). Propensity Score Matching can also be used to evaluate the effectiveness of household damage mitigation measures, as in Hudson et al. (2014b). In this strand of literature the use of Propensity Score Matching is also novel but it is a logical extension to some of the traditional methods used, e.g. Kreibich et al. (2011). The promotion of household damage mitigation measures could form an important part of risk management strategies. This is because, assuming the measures are cost-effective, the aggregate savings in terms of damage prevented could be large. In order to promote efficient damage mitigation measures, accurate estimates of their damage mitigation potential are required. That is, for correctly



assessing the damage mitigation measures' effectiveness from survey data, one needs to control for systematic differences in risk traits. A more refined estimate can be provided if risk characteristics (e.g. the flood hazard faced) differ between individuals who have, or have not, implemented mitigation measures. Hudson et al. (2014b) refine previous estimates by applying Propensity Score Matching to a survey of German households along three major rivers that were flooded in 2002, 2005, and 2006. The application of Propensity Score Matching detected substantial overestimates of mitigation measures' effectiveness, using the methodology of previous studies such as Kreibich et al. (2005) ranging from nearly €1,700 to €15,000 per measure. The refined effectiveness estimates of several mitigation measures show that these measures are still very effective since they are estimated to have prevented between €6,700 and €14,000 of flood damage suffered during a flood event. The most effective mitigation measure is estimated to be a household altering how they use their building. This study concludes with four recommendations regarding how to better apply propensity score matching in future studies within the field of natural hazards research. Overall, this methodology evaluated both a risk reduction measure and a strategy to investigate this. In doing so it was found that household damage mitigation measures are a potentially useful element of future risk management strategies. It was also found that while Propensity Score Matching is a valid evaluation technique its data intense nature limits its applicability to other situations.

3.4 Assessment of risk based insurance pricing incentives for flood risk mitigation

The next methodology being developed, see Hudson et al. (2014c) is based around investigating the effectiveness of risk based insurance premiums to promote household damage mitigation activities. This is done by investigating the ability of risk based premium discounts to incentivise households to carry out cost-effective mitigation measures. In order to investigate the incentivising ability of insurance an integrated model of flood insurance, flood risk and household flood preparedness behaviour is developed. The integrated model is then run twice with two decision rules.

The first decision rule emanates from a compulsory insurance scheme with regionally risk differentiated premium discounts to provide household mitigation incentives. A model of compulsory insurance has been developed because the estimated premiums can be viewed in one of two ways: as a single pooled premium; or as a broad average of individually risk differentiated premiums within a region. This allows the results to be understood within different national contexts, i.e. the compulsory insurance scheme of France; or a free market in Germany.

The second run's decision rule is focused on a risk perception based behavioural model and calibrated using previously published survey data (e.g. Botzen et al., 2009b) regarding the difference between a households subjective and objective flood event probabilities which determine flood preparedness decisions.

These two models operate within a cost-benefit framework, comparing either the objective (insurance incentives) or the subjective (risk perception based) benefits and costs of a household damage mitigation measure. The effectiveness of risk based premium discounts is judged by comparing the mitigation measure employment rates of the two models under a combined projection of flood damage and household numbers in France and Germany unto 2050. Attention is also placed on the observation that the affordability of flood insurance and



risk related incentives may be antagonistic objectives. Therefore, an indicator for judging the affordability of natural hazard insurance is also developed based on a residual income approach with a focus on the poverty line. There have been previous calls for reforming the German and French natural insurance markets, for example by introducing compulsory insurance in Germany or by increasing the role of risk based pricing in France. Therefore, Germany and France are used as test cases of the proposed methodology while at the same time providing an initial evaluation of the proposed reforms. The proposed method could be scaled up to a pan-EU scale if the appropriate sources of data can be found. The model focusing on insurance based decision rules can be scaled up using EU wide flood damage models, however, more detailed and varied estimates of mitigation measure costs would be required. To scale up the risk perception decision rule based model is more difficult. This is because, at the moment, information on mitigation measure employment rates in different regions are rare and very localised. Lacking this knowledge results in the calibration of the risk perception distributions being impossible. Moreover, further development of probabilistic models to maintain a degree of spatial differentiation would improve the accuracy of the model as a whole.

3.5 Analysis through a Risk Reduction Framework

The LSE Risk Reduction Framework is an analytical framework that compares and assesses the effectiveness of seven key aspects of risk reduction and is presented in Surminski and Oramas-Dorta (2013) and Surminski and Eldridge (2014). It is based on scenario risk analyses from publically available information that take into account stakeholder involvement and decisions taken, as well as considering the seven criteria (see below), all of which present how an insurance scheme takes into account risk reduction. Within Surminski and Oramas-Dorta (2013) this method has been used to assess risk reduction for flood insurance in developing countries and has been later used in Surminksi and Eldridge (2014) to specifically assess the risk reduction elements within the present and proposed UK flood insurance schemes.

The seven key criteria assessed are:

- Awareness and knowledge
- The benefits of flood risk management and preventative measures⁶
- Financial incentives to invest in mitigation
- Promotion of resilient reinstatement
- Incentives for public flood risk management policy
- Conditions for compulsory risk reduction
- Incentives present for preventing development in flood risk areas

3.6 Investigation of design principles of insurance

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

⁶ Insurance is one element within the range of flood risk management tools. Used together these approaches harness a broad range of methods to address flood risk, delivering a comprehensive approach which also supports insurance through managing risk.



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 UK highlights the challenges with the existing flood insurance agreement, the Statement of Principles (SoP) recently coming to an end (30th June 2013, currently running as an interim measure) 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. This has a clear emphasis towards affordability and availability of insurance provision, however, provision of flood insurance in the UK is based on a partnership approach: Government is responsible for flood risk management, while the insurance industry provides insurance based on adequate risk management.

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

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.

Achieving all of these aims is proving extremely difficult. The proposed scheme, 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; Defra 2013b). The lack of risk reduction is clear in the official proposal other than in the Memorandum of Understanding, setting out the government's commitment to flood risk management and joint efforts to improve flood risk data (Surminski and Eldridge, 2014).



4 Application to case-studies

As case studies are proceeding and methodologies have been developed to assess the role of insurance instruments, including the incentive effect for reducing risk and building resilience, there are a number of opportunities to apply the methodologies to the cases. This discussion and application is ongoing and will lead to the final deliverable 5.4 that will synthesise results across the cases and particularly distil the potential of key economic and insurance instruments for incentivising risk management. Here we outline where methods have already been applied or discuss the potential use and the scope for innovation across the case studies

An overview of the six methodologies case studies and associated detail can be seen in *Table 3*.

Table 3: Methodologies, aims, data, evidence and link to case studies

Methodology name	Stress testing	Investigation of flood insurance and moral hazard	Estimation of effectiveness of household-level mitigation measures	Assessment of risk based insurance pricing incentives for flood risk mitigation	Analysis through a Risk Reduction Framework	Investigation of the design principles of insurance
Aim	<p>Develop a probabilistic model of losses.</p> <p>Investigate solvency capital needed under Solvency II.</p> <p>Investigate pressure on the EUSF.</p>	To consider if moral hazard is present; if so develop mechanisms to correct this.	To investigate the effectiveness of property level mitigation measures.	To see if compulsory insurance with risk based elements meets both affordability and DRR concerns.	<p>An analytical framework that compares and assesses how an insurance scheme influences seven key aspects of risk reduction;</p> <ul style="list-style-type: none"> -Awareness and knowledge - The benefits of flood risk management and preventative measures -Financial incentives to invest in mitigation - Promotion of resilient reinstatement - Incentives for public flood risk management policy -Conditions for compulsory risk reduction -Incentives present for preventing development in flood risk areas 	To design an insurance system in a way to meet the needs of stakeholders, without compromising the potential for risk reduction elements and a long term focus.
Approach (quant./qual.)	Quantitative	Quantitative	Quantitative and qualitative	Quantitative	Qualitative	Qualitative and quantitative



Data needs	Flood damage model projections Protection standards Insurance penetration rates	Detailed survey of households, with socio-economic and flood risk traits.	Estimates of damage mitigation potential Risk characteristics Details of measures undertaken Cost of measures undertaken Savings on claims A detailed questionnaire on the (past) effectiveness of measures and an estimate of how many households are willing / intend to take the measures.	Flood damage model projection Protection standards Household numbers projections DRR costs and effectiveness estimates	Information on the operation of the scheme Involved stakeholders Financial detail Evidence of risk reduction elements	Information on the operation of the scheme Key principles of the scheme Financial detail
Evidence base (which countries/cases)	EU wide (EUSF)	Germany (indirectly EUSF)	Germany (Hudson et al., 2014b)	Germany and France (Indirectly EUSF)	Flood insurance schemes in UK and low/medium income countries (see Surminski and Oramas- Dorta, 2013; Surminski and Eldridge, 2014)	UK Flood Re
Key Findings	Annual ceiling is likely to be exceeded 80% more likely by 2050.	Moral hazard is not observed.	A more refined estimate can be provided if risk characteristics differ between individuals who have, or have not, implemented mitigation measures. Hudson et al. (2014b) finds substantial overestimates of mitigation measures' effectiveness using the methodology of previous studies such as Kreibich	Risk based premiums are affordable for the majority of the population. Risk based premiums can promote households to reduce risk.	Evidence of risk reduction in UK flood insurance schemes is lacking. Flood insurance is practically non-existent in least developed countries. In developing countries many schemes are at an early stage and have yet to be tested against large events and also may lack comprehensive risk data – posing challenges to	Flood Re is designed based on affordability and availability principles for those at highest risk, yet little formal evidence is in place for effective risk reduction over the life of the scheme.



			et al. (2005) ranging from nearly €1700 to €15 000 per measure. However, the refined effectiveness estimates of several mitigation measures show that these measures are still very effective since they are estimated to have prevented between €6,700 and €14,000 of flood damage suffered during a flood event.		effective delivery and design but risk reduction elements (direct and indirect) are present in 33.3% of the schemes assessed.	
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4.1 Case Study: Port of Rotterdam infrastructure: flood risk

In the case study of the Port of Rotterdam the overarching focus is on assessing risk levels and then establish forms of collaboration between municipality, private sector, port authority and others to address flood risk. Flood insurance is one possible measure included in the discussions, but has not been specifically investigated.

- Stress testing: There is scope to use both elements of this methodology: the probabilistic model and the ‘solvency’ style view of the damage distribution. The solvency mentality combined with a probabilistic model would allow for the direct evaluation of high-impact low-probability events that are key interest to this case study. The cause study focuses on the region of Rotterdam alone means that the key methodological advance of the probabilistic model is not suitable. Moreover, while there is not an insurance scheme currently in place, part of the case study regards the applicability of an insurance scheme, the stress testing methodology could be used to investigate the capital requirements for a Rotterdam based ‘co-op’ style insurance fund. Additionally, by assuming that various business level mitigation measures would work until a specific level in reducing damage by a fixed amount, the use of such a probabilistic model provides a suitable way of evaluating the possible effectiveness of possible mitigation measures.
- Investigation of flood insurance and moral hazard: In Rotterdam there is no insurance scheme that covers a large number of policyholders. Therefore, a methodology for evaluating the presence of moral hazard is not applicable to this case study.
- Estimation of effectiveness of household-level mitigation measures: Rotterdam has not suffered major flood events in the past years due to the high level of protection around the area. Therefore, this instrument is not applicable due to data scarcity.



Moreover, the focus of the case study is on businesses, while the original application focused on household risk reduction measures limiting the degree to which these measures can be applied to businesses.

- Assessment of risk based insurance pricing incentives for flood risk mitigation: The elements of this methodology that could be most suitable for this case study relates to the willingness of business to employ mitigation measures. The case study partners can provide the information required as inputs. This instrument would provide an estimate of the premiums along with an indication of the possible strength of insurance related incentives to promote businesses to employ risk reduction measures. Moreover, this method could be combined with the ‘Stress testing’ methodology to gain a wider understanding of the affordability issues and requirements of a Rotterdam based ‘co-op’ insurance fund.
- Analysis through a Risk Reduction Framework: this is not applicable, as a proper insurance design phase has not started. However, the framework criteria could inform discussion about possible design. Currently the high cost of insurance is considered a key barrier- here the risk reduction framework could be applied to point towards risk reduction measures as a way to make insurance affordable.
- Investigation of the design principles of insurance: As insurance has not been formally explored one would need to organize a structured discussion/workshop between stakeholders to discuss different aims and measures, including insurance. Reflecting on the above risk reduction framework as an illustration of different approaches could prove beneficial for the design should stakeholders agree to proceed.

4.2 Case study: Romania

According to Law 260/2008, homeowners in Romania have to purchase home insurance (PAD), and if they do not, they can be fined (by the local authorities), yet many do not purchase insurance and it is legal to do so due some exceptional clauses related to household economic status. The compulsory home insurance provides cover in case of three natural phenomena: floods, landslides and earthquakes. According to this law, all natural persons and legal entities are required to insure against natural disasters all the homes in the rural or urban environment.

- Stress testing: There is room for employing the probabilistic model approach. The flood risk between the various river catchment areas of Romania could be correlated, which would allow for a more accurate estimation of the total flood risk. Moreover, the model could be further extended to combine all the hazards covered by through the current insurance into a pan-hazard model for Romania. A pan-hazard risk model could offer a better perspective on the total pressure that natural hazards place on compensation mechanisms in Romania. A further possible outcome from the application of this methodology to the Romanian case study would be that by sharing the expected damage across the potential policyholders would provide an indication



of how the mandatory premiums could be adjusted upwards so that the insurance scheme is more robust.

- Investigation of flood insurance and moral hazard: As only 37.65% of households have taken out a flood insurance policy (in 2013) there could be self-selection problems. Use of PSM methodology could correct for this possibility of sample selection. The presence of self-selection creates a strong potential for either moral hazard or advantageous selection to exist, e.g. only the highly risk adverse buy insurance and are more likely to reduce the risk that they face.
- Estimation of effectiveness of household-level mitigation measures: The employment of household mitigation measures could help to reduce flood damage, lessening pressure on insurers or other compensation mechanisms. An application to Romanian risk data appears feasible. This would help to judge the potential of a set of risk reduction measures to reducing the size of flood losses. Additionally, the evaluation methodology could be applied to risk reduction measures commonly employed in Romania.
- Assessment of risk based insurance pricing incentives for flood risk mitigation: The premiums currently charged for flood insurance are not risk based, but there are discussions about a movement towards risk based pricing and the possible impacts. Therefore this investigation could provide useful insights.
- Analysis through a Risk Reduction Framework: The Romanian disaster risk financing framework, in its current form, is rather ex-post oriented. Risk reduction and risk financing is not well linked and the case study aims to address this issue. Here the framework could provide input by illustrating this gap. Data and evidence for the 'four variables' is to some extent available:
 - *Commercial viability* – at the end of 2013, 2,464,186 voluntary home insurance contracts were in force (as compared to 3,324,910 contracts in 2012) and as regards the compulsory home insurance segment, 736,318 contracts were in force. The coverage ratio of the housing sector in Romania, obtained by reporting the number of compulsory and voluntary insurance contracts to the total number of dwellings was 37.65%. There is a large potential market (8.5 million housing), but the standards of living below the EU average, the effects of the economic crisis on consumer behaviour are factors that influence the level of expenditure allocated to insurance.
 - *Financial sustainability* – Considering both voluntary and mandatory insurance policies, recent estimates show that the gross probable maximum loss is about 12.91 billion lei (2.894359 billion EUR), of which 90.96% would be covered by reinsurers. However taking into account the low penetration rate of mandatory insurance (below 20 per cent) as well as the low premium levels, robustness might be a significant issue.
 - *Affordability* – the insurance premium for PAD appears affordable: 20 Euro for type A and 10 euro for type B, yet many do not purchases insurance, so there seems a (perceived) affordability issue.
 - *Vulnerability reduction* – the vulnerability of the Romanian economy and also of the insurance industry is also related to the changing conditions on the foreign markets and the global financial crisis had affected the Romanian



insurance market. There are also internal factors influencing the vulnerability of the insurance sector.

- Investigation of the design principles of insurance: The law 260/2008 provides the basis for the insurance scheme. An assessment of this in terms of risk reduction references is feasible. The law has created a link between the homeowners, the insurance companies/ PAID and the local and central authorities- analysing what there different aims and expectations were/are and how this is reflected in the design would offer some insights for the planned adjustments.

4.3 Case study: Europe/ EUSF

The EUSF, in its current form, is the main post-disaster instrument of the EU. It provides financial aid to MS/candidate countries in case of major (natural) disasters. Considering the EUSF as an EU-wide disaster pool, the case study investigates how its current structure can be reformed to better promote risk reduction and solidarity. One idea here is to use the Fund to support national or regional insurance pools and make available the needed capitalization (linking it back to the Romania case).

- Stress testing: The stress testing methodology can be applied directly to the EUSF in order to investigate the EUSF's insolvency probabilities under various risk reduction investment scenarios. See Jongman et al. (2014) for more information on this application. Moreover, the probabilistic method provides a mechanism for estimating the benefits from investing in structural protection measures.
- Investigation of flood insurance and moral hazard: One concern frequently raised about the EUSF is that it acts as a 'free' funding mechanism for residual losses for national governments. There are two main methodological approaches employed in the investigation in order to robustly judge the presence of moral hazard. One is a direct estimation of the reduction in risk reduction investment (or number of such projects) while the second relates the acceptance of EUSF compensation to a series of risk preference indicators.
- Estimation of effectiveness of household-level mitigation measures: This methodological approach is not relevant to this case study. This is because the measures that would be applied to reduce the risk to the EUSF would be, most likely, large scale engineering projects seeking to reduce the occurrence probability of various natural hazards, rather than household-level measures.
- Assessment of risk based insurance pricing incentives for flood risk mitigation: One focus of this case study regards altering the EUSF so that it contains a mechanism for incentivising risk reduction investments. Assuming that a new structure of the EUSF would contain a risk based element, where contributions are based on investment in risk reduction measures. This methodology could provide an indication of the risk reduction measures that states may be incentivised to take.
- Analysis through a Risk Reduction Framework: This could be applied to the current EUSF roles. Information about the different public bodies and other stakeholders and



their roles is available, data on operation and performance too. The framework might also be useful when comparing existing to newly proposed structure.

- Investigation of the design principles of insurance: For the EUSF the main design principles include solidarity, robustness and promotion of risk reduction. There is literature available to trace back any considerations of risk reduction in the design phase of EUSF, including different stakeholder preferences. This could then be applied to the current discussion about reorienting the EUSF.
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4.4 Case Study: Po River basin

The case study explores controlled flooding on agricultural (low value use) land in order to avoid larger losses in the urban (high value use) areas; and the reform of drought insurance towards an innovative policy mix in which a mutual insurance scheme facilitates temporary water entitlement exchange.

Flood case: There exists no or only a marginal coverage for flood insurance of private properties in the case study area. Based on insurance data for 1980-2013, the share of insured out of total losses is around 5 per cent.

- Stress testing: The probabilistic model approach in this case uses drainage basins and capacity of drainage network as the basic units of observation. In addition, the probabilistic model is combined with identification of the areas along rural-urban divide where deliberate flooding upstream causes lower damage than the uncontrolled floods downstream. An additional benefit is that by developing an entire probabilistic model for the sample area, risk managers have more risk information at their hands. They have access to the full range of moments and quantiles to have an overall view of the damage distribution; this in turn could allow for solvency requirements to be calculated for varying insurance penetration rates in order to judge the possible degrees of pressure that could be placed on an insurance company or sector operating in this region.
- Investigation of flood insurance and moral hazard: The data available is likely to be rather limited due to the very low insurance penetration rate. This makes it unlikely that a large enough sample will be generated for statistical inference to be drawn. The flood protection is a service provided by land reclamation boards (LRB) against a charge all land owners are obliged to pay, according to the level of service provided. The LRB is the entity that would buy insurance for the deliberate harm imposed on agricultural land owners, for sub-optimal network management choices causing unintended damage, and/or for network disruptions due to 'force majeure'. On opposite side, the charge imposed on land owners may be proportional to the private risk mitigation measures. The flood protection service for which the land owner pay would in this case work as actuarial risk pricing.
- Estimation of effectiveness of household-level mitigation measures: The measures that the case study seeks to investigate are novel measures and are not in common



usage across the region, therefore, a backwards looking evaluation method is not suitable.

- Assessment of risk based insurance pricing incentives for flood risk mitigation: A possible use of this method would be an estimation of the actually fair insurance premiums and compare these premiums to an affordability criterion. This comparison would provide an indication of the importance of affordability concerns in explaining the current low penetration rates and the role of risk based pricing.
- Analysis through a Risk Reduction Framework: This could complement the current analysis of three instruments (flood protection tax, land easement, and flood insurance) by comparing those against each other for the seven criteria in the framework. The data and material gathered for the current analysis should enable this additional investigation.
- Investigation of the design principles of insurance: This is a particularly interesting case – as the insurance is specifically designed to cover the deliberate costs arising from a risk-reduction scheme (temporary flooding of land). Understanding the different aims and principles guiding the stakeholders would be very informative. The driving principle is a fair compensation of the incurred losses. Additional principles could be highlighted such as NAI (no adverse impact on downstream areas, or even more stringent form of constant water discharge).

Drought case: A state-subsidized insurance for agriculture (and insurable risks) exists since 1970 and is being now transformed so as to exploit the opportunities of the new rural development program (and the new risk management schemes included therein).

- Stress testing: The development of a new insurance scheme involves an understanding of its solvency needs. The stress testing methodology was developed specifically to investigate the solvency capital required for a fund.
- Investigation of drought insurance and moral hazard: A state-subsidized insurance scheme results in premiums that are lower than the risk based standard. This in turn means that the premiums are providing a too low signal of risk limiting incentives to manage risk. This incentive could be viewed as a moral hazard effect. Part of the methodology employed as part of the ‘moral hazard investigation’ involves a direct estimation of the increase in losses or the reduction in the number of risk prevention activities.
- Estimation of effectiveness of farm-level mitigation measures: The measures that the case study seeks to investigate are novel measures and are not in common usage across the region, therefore, a backwards looking evaluation method is not apropos. However, dependent on the distribution of farmed crops it may be possible to use crop type as a type of mitigation measure in reducing output losses due to droughts. Using this methodology to judge monetary outcomes for this mitigation measures might not be suitable because a drought is hard to judge in terms of its length and its extent and combined with other possible general equilibrium effects.
- Assessment of risk based insurance pricing incentives for flood risk mitigation: Applying this method would result in an estimate of the risk based premiums (i.e. the premiums less the state subsidy) and the relative affordability for landholders. The



affordability criteria in this case would have to be altered to match the affordability concerns of drought insurance policyholders.

- Analysis through a Risk Reduction Framework: A comparison of the existing and the newly proposed scheme could be conducted, similar to the UK case. For the risk reduction focus one could add the ‘water entitlement exchange’ as a key aspect to consider.
- Investigation of the design principles of insurance: The ongoing efforts to design a new insurance scheme provide an opportunity to reflect on aims and principles – possibly through literature or stakeholder engagement. It appears that risk reduction is a key driving factor – exploring this and comparing this to other guiding principles (affordability, viability etc.) would provide insights.

4.5 Case Study: Portuguese wildfire insurance

Forest insurance is mandatory according to article 20 of the Lei de Bases Florestal (Law 33/96) which explicitly demands all publicly funded forest areas to be covered by appropriate insurance. However, the law has not been applied and insurance products are scarce. State initiatives to kick-start forest insurance dates from at least 1999, when a group composed of the National Forest Authority, IFADAP, the Portuguese Insurance Institute and Portuguese Insurance Association worked to expand knowledge on possible schemes and costs.

- Stress testing: The stress testing framework could be used to develop a probabilistic model for the total outcome for the wider region under investigation. A probabilistic model based on the amount of land burnt can be used as a tool to determine the degree of the problem faced by the potential policyholders. This could assist with mobilising support for developing and strengthen a multi-sector partnership as there is a better degree of understanding. A model developed on monetary damage outcomes can estimate the total capital required to for a proposed insurance partnership to be solvent. In doing so an estimate of the expected risk-based premiums, deductibles and capital stocks can provide indications regarding the potential affordability of the partnership.
- Investigation of wildfire insurance and moral hazard: The number of policies is (and has been) small, e.g. forest wildfire insurance has only 14 subscriptions. The potential size of any sample will be too small for a viable statistical analysis. Therefore, applying this method to the Portuguese case study is not feasible until the multi-sector partnership has been developed and expands to include more policyholders. After the partnership has been running for several years there would be the opportunity to employ this methodology. Doing so would evaluate whether the structure and behaviours promoted by the partnership have led to the development of a moral hazard.
- Estimation of effectiveness of household-level mitigation measures: The information offered by the case study means that estimating the effectiveness of the risk reduction measures in monetary terms might be difficult while estimating the effectiveness in terms of total hectares of avoid burnt land might be a better option.



- Assessment of risk based insurance pricing incentives for flood risk mitigation: This approach is based on an estimate of risk based premiums and the effectiveness of various mitigation measures. The data on premiums can be collected from the insurance market or could be derived from the probabilistic model of the ‘Stress testing methodology’. The estimate of the effectiveness of prevention or mitigation measures would need to be estimated directly or indirectly in monetary terms so that the risk based premiums can be adjusted. Combined with cost estimates for the risk reduction measures this would give an indication of the potential of financial incentives to promote policyholders to carry out more risk reduction activities. A potential use of this outcome could be to show governmental actors of the risk reduction benefits of supporting proposed partnerships in order to gain their support for such partnerships.
- Analysis through a Risk Reduction Framework: An assessment of the existing and proposed schemes seems feasible and would provide a very useful analysis of the wildfire insurance study. There are currently four insurance products available. A key question is the pricing and potential subsidy of premiums for landowners. Another aspect currently considered is the inclusion of Forest Intervention Zones (ZIF) which aggregates several landowners from small properties, as an eligible entity to have forest fire insurance. Data for the current scheme is available (see below) – a reflection on risk reduction for existing and newly proposed options could offer new insights on the issue of moral hazard, a key challenge for all fire insurance.
- Investigation of the design principles of insurance: This methodology appears very useful to this case study and would elicit a study of the different design principles that have guided this long-running exercise - such as current use of public funds to restore forest potential (e.g. after fire events); the need to bundle coverage of restoration costs and revenue loss into a single scheme; the need to spread mutualise risk by covering areas in the south (lower risk) as well as in the north (higher risk); prioritization of areas included in Forest Intervention Zones and Landowners’ Associations, as well as those certified, or in the process of certification, according to sustainable forest management schemes; profitability of insurance companies; creation of a new legal framework for forest insurance. Points 1, 3 and 8 from the UK flood insurance example appear relevant for this example.

4.6 Case Study: Flood insurance in England

This case study assesses risk reduction within the current and future flood insurance systems in England. The change to a new system carries some of the previous elements over, including the agreement between government, to provide risk management, and insurers to underwrite flood insurance. However, the proposed new Flood Re scheme does not contain specific risk reduction features.

- Stress testing: The stress testing framework can lead to the development of a probabilistic flood damage model for the households that would be covered by the Flood Re scheme. Once the model has been developed the insolvency probability of Flood Re can be investigated, to judge if its current funding arrangement is suitable.



Additionally, the Stress testing framework can investigate how the introduction of Flood Re may affect the overall solvency of the flood insurance industry.

- Investigation of flood insurance and moral hazard: England has a very well developed private flood insurance market. Moral hazard is one of the constant concerns of the insurance industry. Therefore, conditional on access to detailed information regarding the risk traits and outcomes there may be room for investigating the presence of this behaviour.
- Estimation of effectiveness of household-level mitigation measures: The methodology can be directly applied to flood risk models for England in altering depth damage curves. Conducting a survey in the UK would provide the opportunity to investigate the effectiveness of the particular mix of mitigation measures employed by English households and compare this to findings in other countries.
- Assessment of risk based insurance pricing incentives for flood risk mitigation: Flood Re is being developed in order to promote the affordability of insurance. Part of this methodology is to assess how affordable risk based insurance would be. This could then assist with an investigation of certain measure, such as the potential costs of a voucher scheme to correct for this.
- Analysis through a Risk Reduction Framework: Analysis of the two insurance systems against the seven risk reduction framework criteria shows that there are very little risk reduction features within the new system, Flood Re.
- Investigation of the design principles of insurance: In developing Flood Re the driving principles have been affordability and availability of flood insurance for households, while risk reduction has not been captured in the design of the scheme. There are some measures, such as information sharing, that may lead to greater flood risk awareness. However, it remains unclear how this will play out in practice. Although the detailed plans are not yet in place of exactly how the scheme will operate over its life of 25 years the current discourse is focussed on the operation of the scheme rather than designing the scheme towards reducing risk over time.

Table 4 shows a summary description of the case studies.



Table 4: Summary of case studies, including risk reduction measures and novel approaches.

Name/country	Port of Rotterdam infrastructure: flood risk	Romania	Europe	Po River basin	Portuguese wildfire insurance	Flood insurance in England
Hazard type	Flood risk of unembanked (or outer dike) areas as a result of storm surges in combinations with high river (Rhine) discharges	Flood and earthquake	Natural hazards	Flood and drought	Fire	Flood
Key stakeholders involved in the development/delivery	Province of South-Holland, the municipality of Rotterdam and the Port of Rotterdam Authority. Other stakeholders include businesses acting in the Port of Rotterdam, the citizens working in or near the Port of Rotterdam, DCMR (the environmental protection agency of local and regional authorities) and three water boards, the safety region and the Ministry of Infrastructure and the Environment	Government, local public authority, the private industry of insurance and homeowners.	EU policy-making bodies including DG Regional and Urban Policy and DG Internal Market and Services, primary insurance companies, reinsurers (with a special attention to Europe Re), national governments.	River basin authority, land reclamation and irrigation boards, civil protection agencies. The drought case sees involvement of all major users through the drought steering committee.	UNAC – Union of Farmers Associations for the development of Charneca APS - Portuguese Association of Insurers ICNF – Forest and Nature Conservation Institute	Private insurers cover all aspects of insurance provision, UK Government determine and deliver flood risk management.
Description of insurance instrument (existing and/ or planned)	Flood risk insurance is a topic of ongoing debate, but are currently uncommon and not obligatory. Flood risk insurance in unembanked areas is not yet available in the Netherlands and unlikely to be realized	Voluntary and compulsory home insurance (PAD). A compulsory insurance system (Law 260/2008) for residential properties covering earthquake, landslide and flood risks with homeowners subject to fines for non-purchase.	The EUSF, in its current form, is the main post-disaster instrument of the EU. It provides financial aid to MS/candidate countries in case of major (natural) disasters.	There is no or only a marginal coverage for flood insurance due to compensation by the state after an event. (Based on insurance data for 1980-2013, the share of insured out of total losses is around 5 per cent.) For drought a state-subsidized insurance for	Forest insurance is mandatory under law- yet this is not enforced and insurance products are scarce. A State initiative was in operation from 1999 to 2001. A subsequent	The Statement of Principles; an agreement between insurers and government is currently in operation due to be replaced in Summer 2015 by Flood Re, a pooled approach for the highest risk households,



	without a proper indication of the expected consequences. Companies in the Port of Rotterdam are occasionally insured for flood damage, but this is facilitated by foreign insurers.	According to this law, all natural persons and legal entities are required to insure against natural disasters all the homes in the rural or urban environment. According to the law, constructions are divided in two categories: type A in this case, the insurance premium is 20 Euro and the insured amount 20000 Euro, and type B, in this case the insurance premium being of 10 euro and the insured amount 10000 euro.		agriculture (and insurable risks) has been in operation since 1970.	scheme was started in 2010 covering forests, agriculture and livestock.	delivered and run by private insurers.
Consideration of risk reduction (yes/no – if yes: further details)	Insurance does not reduce societal risk. Insurance aims to spread risk (both spatially as well as in time). With insurance the costs of floods are (more appropriately?) divided between public and private bodies.	The Romanian disaster risk financing framework, in its current form, is rather ex-post. Risk reduction and risk financing is not well linked and the case study aims to address this issue.	As an ex post financing instrument, the EUSF may discourage Member States to invest in preventative measure for risk reduction.	Yes, in both cases although indirectly. For flood insurance the incurred costs are a result of controlled floods whose primary aim is the flood (impact) reduction. In the drought case, the insurance should enable a shift of the available (remaining) water resources from low to high value water uses.	Yes – In an indirect way, the landowners only can have these kind of insurances if they promote an active management of the forested lands, which includes a forest management plan and a wildfire risk assessment.	Risk awareness is included as an element, and Flood Re is required to provide insurers with information to be passed onto to policyholders informing them about the scheme. A national database of property level flood claims is to be shared by insurers with government, while government commits to publication of surface water flood maps and combined flood risk maps. Those under the scheme will move towards risk reflective pricing gradually over 25 years.



						<p>The scheme does not cover property built after 2009 and a 'letter of comfort' states government will provide flood risk management investment and planning policy. No mechanism for monitoring compliance. There are (as of December 2014) no formal plans for any mechanism for risk reduction included in the scheme.</p>
<p>What is novel about the case?</p>	<p>Quantifying flood risk has, as of present, not been conducted for the Port of Rotterdam, this is aimed to be conducted for extremely low probability, extremely high impact events.</p> <p>Enhancing the current MSP and stimulating participation within the MSP leads to a balance in the decision-making process between public (policy makers) and private (company owners or Port Authority) stakeholders and contributes to consensus and increased transparency. Furthermore, exchange of views can lead to a coherent and holistic flood protection strategy for unembanked areas in which involved parties know their</p>	<p>The idea of reorienting the an established insurance scheme to be not only a post-disaster instrument, but also a pre-disaster instrument.</p>	<p>The idea of reorienting the European Union Solidarity Fund (EUSF), EUSF could be not only a post-disaster instrument, but also a pre-disaster instrument.</p>	<p><u>Flood insurance case</u>: flood water is retained on agricultural land, in combination with other risk management instruments including development control, property rights, and insurance. <u>Drought insurance case</u>: A policy mix is applied which paves the way for a revision and reallocation of water entitlements</p>	<p>The insurances are completely private without any support from public funds. So the novelty from this case study will be the integration of public funds (or from the state budget or from the European Union) helping the landowners to support in a more equitable way the insurances premium. In addition, the inclusion of Forest Intervention Zones (ZIF), which aggregates several landowners from small properties, as an eligible entity to have a forest fire insurance.</p>	<p>The way in which UK flood insurance is delivered is unique in comparison with other national schemes- there is no government involvement in the financial detail. Flood Re's approach is focused on affordability and availability for those at high risk.</p>



	responsibilities and are aware of the consequences during a flood					
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5 Conclusion and next steps

Linking physical risk reduction and financial compensation mechanisms for disaster losses is deemed possible in theory, but difficult to achieve in practice. In this paper we determine how one can assess the risk reduction linkages of insurance in cases where insurance does already exist or where the creation of insurance instruments is under consideration. Our investigation is built around four key variables affordability, commercial viability, financial sustainability/solvency, and vulnerability reduction.

Gaining an understanding of how those four variables interact in the context of different insurance offerings is an important first step in our investigation. We show that there are a range of metrics that can be used as indicators for the four variables; However, the availability of and access to data can be a limiting factor particularly in those cases where insurance does not have a long history. In addition there is no overarching formula or definition used for any of those four concepts, and one can observe different interpretations and approaches across stakeholders and case studies. For example, affordability can be a very normative concept, while commercial viability is likely to be perceived differently between public and private actors. Therefore it would be important to clarify those four concepts and the underlying metrics for each particular case.

Beyond the terminology issue we notice that relatively few assessments have been conducted to consider how these four variables interact. While a more detailed investigation of the underlying relationships between those four variables is still ongoing, we can observe potential trade-offs between those four variables. For example, attempts by some stakeholders to make insurance more affordable may result in premiums which insurers believe don't offer a sufficient return for investors to provide capital.

This is of particular importance when considering the development of a new insurance scheme or the assessment of an existing insurance offering: what happens to affordability in the short and long-term if risk based pricing is introduced? And how could risk reduction, such as investment in flood risk management, reduce the stress on the system, influence financial sustainability and commercial viability?

These are some of the questions raised in the current discussions in the six case studies, but they have relevance beyond these examples, as highlighted by the recent discourse on the EU Green Paper on Disaster Insurance (Surminski et.al. 2015).

5.1 Initial findings from the six methodologies

In this paper we have introduced six different methods that seek to provide answers to these questions. Their initial application to some of the case studies has revealed some interesting findings:



- The stress testing approach suggests that the annual ceiling of the pre-reform EUSF is likely to be exceeded 80% more likely by 2050. The investigation of moral hazard finds no evidence of moral hazard for the cases of Germany and the USA. Further investigation would be of interest, particularly for those cases where systems have been in existence for a longer time, such as England. This would help testing the observation from Germany and the US and determine the validity of these findings across different countries.
- The assessment of the effectiveness of household level protection measures suggests a substantial overestimation of mitigation measures' effectiveness in previous studies. However, the refined effectiveness estimates of several mitigation measures show that these measures are still very effective since they are estimated to have prevented between €6,700 and €14,000 of flood damage suffered during a major, flood event.
- The assessment of risk based premiums suggests that they are affordable for the majority of the population and can promote households to reduce risk. An application across countries and insurance schemes is essential to further investigate these initial observations.
- The risk reduction framework investigation reveals that direct linkages between risk reduction and insurance is lacking in most insurance schemes. This raises the question of how innovation and stakeholder collaboration could help overcome this limitation.
- The consideration of design principles highlights that there appears to be trade offs between affordability, availability, and vulnerability reduction, particularly when considering the political realities that drive the reform or development of new insurance schemes.

These indicative findings are based on particular cases and the transferability of any of those results remains to be seen. Nevertheless they offer some relevant pointers in response to our underlying questions about linkages between insurance and risk reduction.

5.2 Observations from the case study applications

By bringing together theoretical work, qualitative and quantitative approaches, and case-study evidence from across Europe under the ENHANCE project we can make the following observations:

- Diversity of methods: The results of Jongman et al. (2014) show that socio-economic development and climate change can substantially increase pressure on risk transfer or financing mechanisms, like insurance. However, flood risks are the result, in part, of the flood preparedness activities undertaken by households and other policyholders. This offers an opportunity for household level risk reducing activities to be integrated to (trans-)national risk management strategies. Household level flood risk mitigation activities could be



used as a mechanism for reducing the pressure placed on risk transfer schemes in response to increasing stress. Therefore, evaluating different aspects of household behaviour can also provide information for assessing current risk financing schemes. In this respect, it is important to arrive at insights into whether insurance results in a moral hazard effect whereby individuals take fewer measures that limit flood damage once they have insurance coverage, and/or whether insurance incentives, such as premium discounts, can be effective in stimulating people to take more flood risk mitigation measures. The investigation of households is based on three objectives: (1) identifying and quantifying the potential presence of moral hazard; (2) estimating the effectiveness of household damage mitigation measures; and (3) investigating the effectiveness of risk based premiums to promote households to employ these damage mitigation measures. These first two investigations are not directly related to a single case study due to limited data availability. Nevertheless, the results and insights can be used as a part of the insurance related case-studies. The third study currently develops a method for specific countries which later on in the project can be refined before being applied at a larger scale, such as the EU and the European solidarity fund.

- **Data intensity:** moral hazard investigation and estimation of effectiveness of household level flood risk mitigation measures are data intense, therefore have limited applicability. Both would require in depth surveys of households in order to have an adequate level of information regarding the various behaviours and risk traits (e.g. the hazard households face, how vulnerable are households to damage, the value of what households have to damage, etc.) of households. The detailed questionnaires are likely to be expensive and time consuming to produce a sample that is representative of a region or a nation, let alone a sample that is representative of Europe as a whole. Rather, a series of localised studies may be a more effective use of resources, than a single pan-EU study may be. Localised studies, such as Kreibich et al. (2005) and Poussin et al. (2013) for example, can be used as part of the input into larger theoretical scale models to provide a wider geographical coverage.
- **Applicability:** the applicability depends to some extent on the development stage of insurance in the particular case investigated. In those examples where insurance has already been available for some time, such as the UK, all six methodologies are deemed to be applicable. In those cases where insurance is only considered as a potential option, such as the Rotterdam case, determining which methods could be applied at this initial stage is more complex. However, a part from the investigation of moral hazard we find that there is potential for the other five methods even at such an early stage. Additionally, all five case studies exemplify that different stakeholders have different constellations and problem definitions; however for all there appears to be value in applying most of the methodologies. This attests a degree of flexibility in interpreting the findings. For example the Portuguese case indicates that a reflection on underlying design



principles could be a very useful approach to provide critical reflections on the ongoing insurance deliberations.

- **Stakeholder engagement:** This is important in order to discover current barriers, perceived or otherwise, that are inhibiting innovation or new partnerships. For example, it may be that the level of risk itself is inhibiting the partnership or that the stakeholders do not have a suitable platform upon which to engage. Moreover, stakeholder engagement can– also clarify the different understandings of the variables as without a common understanding the stakeholder objectives may appear to be unresolvable. This is apparent in the case of the design principles. In most cases this has not been properly documented and would require further stakeholder discussions.
- **Multiple-objectives/Multiple-instruments:** Several of the case studies (or wider, see Surminski et al., (2015) for examples) seek to develop new MSP but have failed. One reason for this impasse may be that the stakeholders are trying to achieve too many different objectives and criteria with a single instrument. Stakeholders may have to see insurance as an instrument that interacts with other instruments in order to achieve the stakeholder objectives, especially if several stakeholders have opposing objectives. For example by using risk based insurance to promote DRR while also providing a voucher scheme to address affordability.

5.3 How can this support the development of novel MSPs?

The five case studies are deliberately diverse. One key unifying aspect is the quest for novel approaches and solution in the face of rising disaster risks. In the England case we have two very distinctive features: an evolving public-private relationship and a temporal consideration of affordability – with Flood Re proposed as a temporary measure to ease the transition to risk based pricing. In Italy the intention is a combination of different risk management instruments, including insurance to address flooding and drought. In Portugal the novel aspect is the intention to integrate public funds and private insurance in a way that supports risk reduction, as well as the inclusion of Forest Intervention Zones to assist small landowners to gain access to insurance. The Rotterdam case focuses on the quantification of flood risk in a participatory way, engaging the different stakeholders to better understand risks, which in turn is expected to provide the basis for a common strategy of managing flood risk, of which insurance might be apart. The Romanian and EUSF case considers the re-orientation of the EUSF from a post-disaster to a pre-disaster instrument, with a focus on how best to align this public form of compensation with existing and proposed insurance schemes.

Progress in the area connecting or using DRR and disaster insurance can help with the development of MSPs, by making the MSPs more sustainable and resilient to risk



However, this 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.

In order to improve the link with insurance and disaster risk reduction in the EU, future research should provide insight into several issues, as by doing so a commonly cited barrier to the development of MSPs can be removed (Surminski et al., 2015). Namely: local risk estimations and their implications for the differentiation of premiums according to local risks, the costs and benefits (avoided damage) of risk mitigation measures that can be implemented by policyholders and the performance of such measures under a variety of conditions. In addition the effectiveness of insurance incentives, such as premium discounts, in stimulating policyholders to adopt risk mitigation measures including possible moral hazard effects of insurance coverage, and barriers for insurance companies to proactively stimulate policyholders to limit risks.

The suitability of insurance depends on the particular risks, political objectives and the design of a proposed scheme. Insurance is provided publicly, privately, through a partnership, subsidized or mandated – guided either by the principle of solidarity or considered as a risk-based market mechanism.

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. (Surminski 2015)

We argue that until today efforts to reform disaster compensation mechanisms in Europe have been predominantly focused on dealing with the financial losses, without considering the implications of these mechanisms for managing and reducing the underlying risks. (Surminski et.al. 2015). The integration of mechanisms for more active risk management and reduction would reduce the pressure placed on the current (or potential) MSP stakeholders. This in turn offers opportunities for the (further) development of MSPs, as the various stakeholders will be given tangible tasks within their ability to accomplish. Attempting to complete these tasks could lay the foundations of future and deeper co-operation between the various stakeholders. This is because by working together on accomplishable tasks some of the barriers for stakeholder interaction will be removed at the same time as developing a community's resilience to natural hazards.



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7 Appendix: Detailed case study information

7.1 Case study: Port of Rotterdam infrastructure: flood risk

Hazard type

Flood risk of unembanked (or outer dike) areas as a result of storm surges in combinations with high river (Rhine) discharges.

Key stakeholders involved in the development/delivery

The key stakeholders are the Province of South-Holland, the municipality of Rotterdam and the Port of Rotterdam Authority. The Province and the municipality are principally responsible for the current spatial planning / development policy for outer dike areas. The Province and the municipality form the current MSP.

Other stakeholders are the businesses (i.e. the private companies) acting in the Port of Rotterdam, the citizens working in or near the Port of Rotterdam, DCMR (the environmental protection agency of local and regional authorities) and three water boards, the safety region and the Ministry of Infrastructure and the Environment (see section 1.1 in D7.2).

Note that the Municipality of Rotterdam and the Port of Rotterdam Authority aim to work together on reducing flood risk and improving flood safety. In marketing terminology the Municipality is an early adaptor and the Port of Rotterdam Authority is a laggard.

Description of insurance instrument (existing and/or planned)

Flood risk insurance (in embanked areas) are a topic of ongoing debate, but are currently uncommon and not obligatory. It is furthermore unclear to what extent such an insurance is financially feasible. Flood risk insurance in unembanked areas is not yet available in the Netherlands and unlikely to be realized without a proper indication of the expected consequences. Companies in the Port of Rotterdam are occasionally insured for flood damage, but this is facilitated by foreign insurers.

Consideration of risk reduction with respect to insurance (yes/no – if yes: further details):

Flood insurance is one of the measures we consider. Insurance does not reduce societal risk. Insurance aims to spread risk (both spatially as well as in time). With insurance the costs of floods are (more appropriately?) divided between public and private bodies.

What is novel about the case? with respect to insurance?

To date the flood risk of the port of Rotterdam area has never been quantified. Some qualitative studies have been performed. The flood events under consideration are in the category “extremely low probability, extremely high impact”. Climate change will adversely affect the probability. The hypothesis is that (part of) the flood risk of the port of Rotterdam is not acceptable or at least that flood risk should be reduced. If the hypothesis turns out to be true, any measure that reduces societal risk can be helpful.

“Enhancing the current MSP and stimulating participation within the MSP leads to a balance in the decision-making process between public (policy makers) and private (company owners or Port Authority) stakeholders and contributes to consensus and increased transparency. Furthermore, exchange of views can lead to a coherent and holistic flood protection strategy for unembanked areas





in which involved parties know their responsibilities and are aware of the consequences during a flood.”

Quantifying flood risk is a first step.

Design principles (aim of the scheme as stated/agreed by partners)

Yet unknown

Roles and responsibilities of partners

Yet unknown

Evidence for any assessment of ‘four variables’ (commercial viability, financial sustainability, affordability, and vulnerability reduction):

Yet unknown

P.S. The problem is that the insurance fee (for businesses) will likely to be very high as the cumulative insurance fees cannot cover the consequences of one major flood event in the next 30 years or so.

7.2 Case study: Romania

Hazard type

Flood and earthquake

Key stakeholders involved in the development/delivery

Government, local public authority, the private industry of insurance and homeowners.

Description of insurance instrument (existing and/ or planned)

Voluntary and compulsory home insurance (PAD). The owners of residential properties must insure their buildings against earthquake, landslide and flood risk. According to Law 260/2008, homeowners in Romania have to purchase home insurance (PAD), and if they do not, they can be fined (by the local authorities). The compulsory home insurance provides cover in case of three natural phenomena: floods, landslides and earthquakes. According to this law, all natural persons and legal entities are required to insure against natural disasters all the homes in the rural or urban environment. According to the law, constructions are divided in two categories: type A in this case, the insurance premium is 20 Euro and the insured amount 20000 Euro, and type B, in this case the insurance premium being of 10 Euro and the insured amount 10000 Euro.

Consideration of risk reduction (yes/no – if yes: further details)

The Romanian disaster risk financing framework, in its current form, is rather ex-post. Risk reduction and risk financing is not well linked and the case study aims to address this issue.

What is novel about the case?

Developing a risk reduction and risk financing approach for an established ex post scheme.

Design principles (aim of the scheme as stated/agreed by partners)

The law 260/2008 has created a link between the homeowners, the insurance companies/ PAID and the local and central authorities.

Roles and responsibilities of partners



The *EUSF* provides financial aid in case of major (natural) disasters. The main responsibilities of the *Government* are related to strategies for risk reduction and allocation of funds. *The Insurance Pool against Natural Disasters (PAID) and other authorized insurance companies* are supplying insurance and handling the process of paying out claims. *Local public authorities* take measures for prevention of risks, the fines for not having mandatory home insurance (PAD) are the responsibility of local public authorities, take measures in case of the occurrence of the natural risk (evacuation, shelter etc.). *Homeowners* have an important role in the prevention of risks of floods, earthquake and landslide, through the acquisition of the policy of insurance against natural disasters.

Evidence for any assessment of 'four variables'

Commercial viability – at the end of 2013, 2,464,186 voluntary home insurance contracts were in force (as compared to 3,324,910 contracts in 2012) and as regards the compulsory home insurance segment, 736,318 contracts were in force. The coverage ratio of the housing sector in Romania, obtained by reporting the number of compulsory and voluntary insurance contracts to the total number of dwellings was 37.65%. (FSA, 2014). There is a large potential market (8.5 million housing), but the standards of living below the EU average, the effects of the economic crisis on consumer behaviour are factors that influence the level of expenditure allocated to insurance. *Financial sustainability* – Considering both voluntary and mandatory insurance policies, recent estimates show that the gross probable maximum loss is about 12.91 billion lei (2.894359 billion EUR), of which 90.96% would be covered by reinsurers (FSA, 2014). However taking into account the low penetration rate of mandatory insurance (below 20 per cent) as well as the low premium levels, robustness might be a significant issue. *Affordability* – the insurance premium for PAD is affordable: 20 Euro for type A and 10 euro for type B. *Vulnerability reduction* – the vulnerability of the Romanian economy and also of the insurance industry is also related to the changing conditions on the foreign markets and the global financial crisis had affected the Romanian insurance market. There are also internal factors influencing the vulnerability of the insurance sector. European level: under investigation

7.3 Case study: Europe

Hazard type

Flood and earthquake

Key stakeholders involved in the development/delivery

EU policy-making bodies including DG Regional and Urban Policy and DG Internal Market and Services, primary insurance companies, reinsurers (with a special attention to Europe Re), national governments

Description of insurance instrument (existing and/ or planned)

The EUSF, in its current form, the main post-disaster instrument of the EU. It provides financial aid to MS/candidate countries in case of major (natural) disasters. Considering the EUSF as an EU-wide disaster pool, we are investigating how its current structure can be reformed to better promote risk reduction and solidarity. One idea here is to use the Fund to support national or regional insurance pools and make available the needed capitalization.

What is novel about the case?

The idea of reorienting the European Union Solidarity Fund (EUSF), EUSF could be not only a post-disaster instrument, but also a pre-disaster instrument.

Design principles (aim of the scheme as stated/agreed by partners)



The main design principles include solidarity, robustness and promotion of risk reduction.

Roles and responsibilities of partners

DG Regional and Urban Policy (DG Regio) holds the main responsibility over the EUSF. *DG Regio* has the relevant expert knowledge, while the Council and the Parliament take political decisions. *DG Internal Market and Services (DG MARKT)* is directly responsible for the financial services within the EU including the supervision of the insurance market. *Primary insurance companies* provide flood and earthquake insurance for households, businesses and governments. In addition to risk transferring, a well-designed insurance system also has the potential to encourage risk reduction. *Member States governments* have implicit and explicit liabilities in the context of natural disasters. In addition, they have a key role in risk reduction, ensuring solidarity and creating appropriate market conditions.

Evidence for any assessment of 'four variables'

Under investigation

7.4 Case study: Po River basin

Hazard type

Floods, in connection to the disrupted water drainage infrastructure as a consequence of the 2012 earthquake; and droughts.

Key stakeholders involved in the development/delivery

The full description of the stakeholders involved or affected by the analyzed instruments can be found in the case study reports D71, and D7.2. In brief, for the flood case, river basin authority, land reclamation and irrigation boards, civil protection agencies. The drought case sees involvement of all major users through the drought steering committee.

Description of insurance instrument (existing and/ or planned)

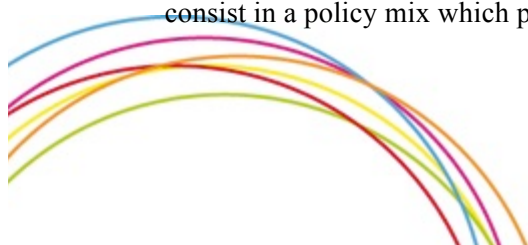
Flood case: there is no or only a marginal coverage for flood insurance. (Based on insurance data for 1980-2013, the share of insured out of total losses is around 5 per cent.) This is partly because Italy compensates the private (household) losses in the aftermath of a major hazard strike from public budget, with limitation. The case study analyses controlled floods (*transient flood storage on agricultural land*), in order to avoid larger losses in the urban areas. Our case will show the avoided and (much lower) incurred damage. As next, we analyze how the incurred losses can be recovered. The considered options are (i) flood (protection) tax which already exists to recover the costs of water drainage, or more general land property tax; (ii) land easement (that is restriction of land property rights) with compensation; and (iii) flood insurance scheme subscribed either by property holders or land and reclamation boards themselves. **Drought case:** A state-subsidized insurance for agriculture (and insurable risks) exists since 1970 and is being now transformed so as to exploit the opportunities of the new rural development program (and the new risk management schemes included therein). Our analysis focusses on willingness to pay for income stabilization insurance, and a policy mix in which a mutual insurance scheme facilitates temporary water entitlement exchange.

Consideration of risk reduction

Yes, in both cases but perhaps indirectly. In flood case, the insurance refers to the incurred costs as a result of controlled floods whose primary aim is the flood (impact) reduction. In the drought case, the insurance should enable a shift of the available (remaining) water resources from low to high value water uses.

What is novel about the case?

Flood case: the innovation lays in the flood water retention on agricultural land, in combination with other instruments including development property rights, and insurance. **Drought case:** the innovation consist in a policy mix which paves the way for a revision and reallocation of water entitlements.





Design principles

In both cases the proposed schemes extend or complement the current agreement. In *flood case*, the driving principle is a fair compensation of the incurred losses. Additional principles could be highlighted such as NAI (no adverse impact on downstream areas, or even more stringent form of constant water discharge).

7.5 Case study: Portuguese wildfire insurance

Name/country

District of Santarém, where the municipality is included

Hazard type

Forest wildfires

Key stakeholders involved in the development/delivery

UNAC – Union of Farmers Associations for the development of Charneca

APS - Portuguese Association of Insurers

ICNF – Forest and Nature Conservation Institute

Description of insurance instrument

Forest insurance is mandatory according to article 20 of the Lei de Bases Florestal (Law 33/96) which explicitly demands all publicly funded forest areas to be covered by appropriate insurance. However, the law has not been applied and insurance products are scarce. State initiatives to kick-start forest insurance dates from at least 1999, when a group composed of the National Forest Authority, IFADAP, the Portuguese Insurance Institute and Portuguese Insurance Association worked to expand knowledge on possible schemes and costs. The group was eventually dissolved in 2001. The following initiative, in 2010, was created within the Ministry with the objective of studying not only forest insurance but also agricultural and livestock insurance schemes. The main conclusions pinpointed conflicts with current use of public funds to restore forest potential (e.g. after fire events) and the need to bundle coverage of restoration costs and revenue loss into a single scheme. The working group also highlighted the need to spread mutualise risk by covering areas in the south (lower risk) as well as in the north (higher risk). Priority should be given to areas included in Forest Intervention Zones and Landowners' Associations, as well as those certified, or in the process of certification, according to sustainable forest management schemes. The initiative eventually led to detailed work for a new forest insurance adapted to the level of profitability of the sector, and spurring forest investment and active forest management. The direction taken would turn IFAP⁷ into the manager of the State-backed insurance and would be coupled with a new legal framework for forest insurance.

Current insurance products

There are currently four insurance products covering the forest products or forest land. This section gives a description of each insurance product. All insurance products require extensive information on the object insured. For insurance covering forest areas, companies typically request information on the location, size, stand data (e.g. species, schedule of operations, past events), management practices (e.g. firebreaks, maintenance of road network), distance to industrial facilities and landfills, among other.

⁷ IFAP (Instituto de Financiamento da Agricultura e Pescas) is the public organism responsible for managing national and EU funds for the primary sector in Portugal.



Risk assessment may also be supported by information produced for the Municipal Forest Fire Protection Plans and Municipal Operational Plans.

Indicators for the CA Incêndio Florestal (Forest wildfire) Insurance:

	Indicators	Description			
General characteristics	Programme name and year of establishment	CA Incêndio Florestal - 2009			
	Programme duration	Temporary (max one year; subscription is only possible January through April)			
	Standard disaster return period	Undisclosed			
	Damage intensity	Undisclosed			
	Compulsory coverage	Voluntary			
	Market penetration	14 subscriptions; approximately 3000 ha			
	Official trigger	No			
	Responsibility public sector	There is no public participation in the programme			
	Responsibility private sector	Risk assessment, policy conditions, market development, management			
Funding	Hazard covered	Forest fire (excluding, auto-ignition, caused by earthquake or underground fire)			
	Damage covered	Damage to trees (including, bark in the case of cork oak)			
	Limit of indemnity	Two options: 100% or 75% of the insured capital)			
	Individual policy deductibles	Two options (10% or 20%) with varying minimum area as deductible. See table below:			
		Insured forest area	Minimum burned area		
			10% deductible	25% deductible	
			50 to 499	10	25
			500 to 999	25	55
	1000 to 2499	55	135		
	Premium setting	Premiums are risk-based according but lumped by target beneficiary (e.g. landowners from Aflosor have higher premiums than Ansub, mainly due to the 2003 forest fire)			
Premium level	Ranges from €3/ha to €60/ha (1-5% of insured capital which can range from €300-1200/ha)				
Reinsurance	Undisclosed				
Reserves and special tax treatment	Undisclosed				
DRM	Integration of risk mitigation and preventive measures	Measures are integrated (quotation form requires information regarding equipment available, fuel management operations, cooperation with neighbours, etc.). Impact on premiums is dubious.			
	Risk zoning and risk maps	Risk zoning and risk maps are produced at municipal level every year by local authorities, which are used by the insurance company			
	Incentives based on premiums	Uncertain. Risk zones are predefined and determine premiums, although mitigation and prevention measures are asked for.			
	Incentives based on deductibles	No. Deductibles have two options and standard values, independent of measures undertaken.			

Indicators for the CA Incêndio Agrícola (Agriculture fire) Insurance:

	Indicators	Description
a r a	Programme name	CA Incêndio Agrícola





	<i>and year of establishment</i>	
	<i>Programme duration</i>	Temporary (subscription is only possible January through April)
	<i>Standard disaster return period</i>	Undisclosed
	<i>Damage intensity</i>	Undisclosed
	<i>Compulsory coverage</i>	Voluntary
	<i>Market penetration</i>	Undisclosed
	<i>Official trigger</i>	Yes, for cyclonic wind
	<i>Responsibility public sector</i>	There is no public participation in the programme
	<i>Responsibility private sector</i>	Risk assessment, policy conditions, market development, management
<i>Funding</i>	<i>Hazard covered</i>	Fire, lightning, explosion, cyclonic wind (>80 km/h) and landslide (exclusions: auto-ignition, earthquake, underground fire, vandalism, among other)
	<i>Damage covered</i>	Bee hives, cork, hay and straw, harvested wood and firewood, and identified trees
	<i>Limit of indemnity</i>	Subject to individual conditions
	<i>Individual policy deductibles</i>	10% (for cork under €400/ha; bee hives, harvested wood) 25% (for cork over €400/ha; trees)
	<i>Premium setting</i>	Undisclosed
	<i>Premium level</i>	Undisclosed
	<i>Reinsurance</i>	Undisclosed
	<i>Reserves and special tax treatment</i>	Undisclosed
<i>DRM</i>	<i>Integration of risk mitigation and preventive measures</i>	Areas where products are stored must be kept free of shrubs, straw or any other type of vegetation; Bee hives must have a clean zone of 10 m radius
	<i>Risk zoning and risk maps</i>	Risk is assessed at the site where products are kept;
	<i>Incentives based on premiums</i>	Unknown
	<i>Incentives based on deductibles</i>	Unknown

Indicators for the Fidelidade Seguro de Reflorestação (reforestation) Insurance:

	Indicators	Description
<i>General characteristics</i>	<i>Programme name and year of establishment</i>	Fidelidade Seguro de Reflorestação
	<i>Programme duration</i>	Temporary (max one year)
	<i>Standard disaster return period</i>	Undisclosed
	<i>Damage intensity</i>	Variable (scheme allows for reforestation, natural regeneration and restoration of stand)
	<i>Compulsory coverage</i>	Voluntary
	<i>Market penetration</i>	No policies since October 2013
	<i>Official trigger</i>	No
	<i>Responsibility public sector</i>	There is no public participation in the programme
	<i>Responsibility private sector</i>	Risk assessment, policy conditions, market development, management
	<i>Hazard covered</i>	Fire, explosion and lightning (including, damages caused by vandalism)





	<i>Damage covered</i>	Damages to forested and managed areas	
	<i>Limit of indemnity</i>	Insured capital from €300-1000/ha for softwoods, cork oak and holm oak; from €300-1500/ha for eucalyptus	
	<i>Individual policy deductibles</i>	20% deductible and the following minimum area as deductible:	
		Forest stand (ha)	Deductible burned area (ha)
		1-5	0,1
		5-20	0,5
		20-50	1
		> 50	3
	<i>Premium setting</i>	Undisclosed	
	<i>Premium level</i>	Undisclosed	
<i>Reinsurance</i>	Undisclosed		
<i>Reserves and special tax treatment</i>	Undisclosed		
DRM	<i>Integration of risk mitigation and preventive measures</i>	Stands required Forest Management Plan and the implementation of risk reduction practices	
	<i>Risk zoning and risk maps</i>	Risk zoning and risk maps are produced at municipal level every year by local authorities, which are used by the insurance company	
	<i>Incentives based on premiums</i>	Unknown	
	<i>Incentives based on deductibles</i>	Unknown	

Indicators for the Fidelidade Incêndio Agrícola (Agriculture fire) Insurance:

	Indicators	Description
General characteristics	<i>Programme name and year of establishment</i>	Fidelidade Incêndio Agrícola
	<i>Programme duration</i>	Temporary (subscription is only possible January through April)
	<i>Standard disaster return period</i>	Undisclosed
	<i>Damage intensity</i>	Undisclosed
	<i>Compulsory coverage</i>	Voluntary
	<i>Market penetration</i>	Undisclosed
	<i>Official trigger</i>	Yes, for cyclonic wind
	<i>Responsibility public sector</i>	There is no public participation in the programme
	<i>Responsibility private sector</i>	Risk assessment, policy conditions, market development, management
Funding	<i>Hazard covered</i>	Fire, lightning, explosion and, for harvested wood, trees, cork, resin, and machinery, cyclonic wind (>100 km/h) (exclusions: auto-ignition, earthquake, underground fire, vandalism, among other)
	<i>Damage covered</i>	Bee hives, cork, hay and straw, harvested wood and firewood, trees, resin and agricultural machinery and equipment
	<i>Limit of indemnity</i>	Subject to individual conditions
	<i>Individual policy deductibles</i>	30%
	<i>Premium setting</i>	Undisclosed
	<i>Premium level</i>	Undisclosed
	<i>Reinsurance</i>	Undisclosed
	<i>Reserves and special tax treatment</i>	Undisclosed





DRM	<i>Integration of risk mitigation and preventive measures</i>	Undisclosed
	<i>Risk zoning and risk maps</i>	Risk is assessed at the site where products are kept; insured entity must notify insurance company of any changes to risk
	<i>Incentives based on premiums</i>	Unknown
	<i>Incentives based on deductibles</i>	Unknown

Consideration of risk reduction

Yes – In an indirect way, the landowners only can have these kind of insurances if they promote an active management of the forested lands, which includes a forest management plan and a wildfire risk assessment.

What is novel about the case?

As seen above, the insurances are completely private without any support from public funds. So the novelty from this case study will be the integration of public funds (or from the state budget or from the European Union) helping the landowners to support in a more equitable way the insurances premium. At the moment, premiums vary in a significant amount, you are in a low-risk or high risk area, and it is not even consider in the north of Portugal where the risk is much higher than in the south, and the properties are much smaller.

The second novelty it is the inclusion of Forest Intervention Zones (ZIF) which aggregates several landowners from small properties, as an eligible entity to have a forest fire insurance.

Design principles (aim of the scheme as stated/agreed by partners)

We don't have design principles, however we think we could work on points 1, 3 and 8.

ICNF – supply of actualized data, in a format which allows the insurance companies and landowners to do a forest risk assessment in an easy and comprehensible manner.

Roles and responsibilities of partners

UNAC – To share their experience of risk reduction and risk sharing as well as with the promotion of the new products that can arise from the project.

APS – to discuss, share and promote the tools and methodologies for a more attractive forest insurance to individual landowners and ZIF's.

Evidence for any assessment of 'four variables' (commercial viability, financial sustainability, affordability, and vulnerability reduction)

Since it is new, there isn't any experience or evidence.

7.6 Case study: Flood Insurance in England

Hazard type

Flooding

Key stakeholders involved in the development/delivery

Private insurers

UK government



Description of insurance instrument (existing and/or planned)

The Statement of Principles, which is an agreement between the UK government and the Association of British Insurers, was established in 2000 in the wake of growing flood losses and sets commitments from both the insurance industry and government to establish flood insurance provision. The main obligations can be summarised as follows: flood insurance is provided by private insurers under the Statement of Principles to both households and small businesses, generally up to a risk level of 1:75 return period (RP) (1.3%) as part of their building and/or content cover. Properties at higher risk are granted cover if insurers are informed by the Environment Agency about plans for flood defence improvements for the particular area within the next five years. Government commits to investment in flood defences and improved flood risk data provision as well as a strengthened planning system. Under this agreement, the emphasis on flood risk reduction is primarily placed on the government (national and local) as insurers play more of a financial supporting role with little mention of how insurance can promote effective flood risk reduction measures. The 2007 UK floods triggered a review of the Statement of Principles, with a renewed version being put in place from 2009 until June 2013.

After more than two years of negotiation between government and industry, a new flood insurance system Flood Re, was proposed by government in summer 2013. The Statement of Principles (SoP) officially ended on the 30th June 2013, but is still in operation whilst the political debate about the new Flood Re system continues, with the aim to finalise and implement the new scheme by mid-2015. The proposed system, which creates an insurance pool for properties at high risk of flooding, is presented by government and industry as a roadmap to future affordability and availability of flood insurance, with an anticipated run-time of 20 to 25 years (Defra and ABI 2013).

The Flood Re scheme will provide households under low to normal risk with standard insurance and high risk properties will be insured through the Flood Re pool. The subsidy for high risk households is claimed from a levy taken from all policyholders, on average £10.50 per policy, and also imposed on insurers according to their market share. The premiums offered for high risk households are fixed dependent on council tax banding and cover is offered at a set price based on what is felt to be initially affordable. The government proposal is that small businesses will not be covered by the Pool unless they operate from home with a domestic insurance policy in place. Policy excesses are intended to be limited to between £250 and £500. Several other technical aspects remain unclear, including the handling of flood losses beyond a suggested cap of 1 in 200 loss event, and will be subject to debate between insurers and government.

Consideration of risk reduction with respect to insurance (yes/no – if yes: further details):

Under the Statement of Principles (SoP), the emphasis on flood risk reduction is primarily placed on the government (national and local) as insurers play more of a financial supporting role with little mention of how insurance can promote effective flood risk reduction measures. Nevertheless, the insurance industry has played an important role in updating the planning system with representatives from the Association of British Insurers (ABI) involved in government working groups and promoting the PPS25 to local planners at government sponsored events. In the wake of improvements to the planning system the ABI decided that from 2009, newly build properties would no longer be part of the SoP agreement, arguing that compliance with the updated planning rules would mean that those new properties could obtain flood insurance in the market.

Under the new Flood Re system, risk awareness is included as an element and Flood Re is required to provide insurers with information to be passed onto to policyholders informing them about the



scheme. A national database of property level flood claims is to be shared by insurers with government, with government committing to publication of surface water flood maps and combined flood risk maps. In addition, households under the scheme will move towards risk reflective pricing gradually over 25 years. Finally, the scheme does not cover property built after 2009 and a ‘letter of comfort’ states government will provide flood risk management investment and planning policy. However, there is no mechanism for monitoring compliance and there are (as of December 2014) no formal plans for any mechanism for risk reduction included in the scheme.

What is novel about the case? with respect to insurance?

Flood insurance across the United Kingdom is unique amongst most other national schemes as it is purely underwritten by the private market, while government commits to flood risk management activities. There is no government involvement in the financial detail at all. Flood Re’s approach focuses on affordability and availability and only covers those at highest risk.

Design principles (aim of the scheme as stated/agreed by partners)

At the start of the negotiations for a new flood insurance scheme to replace the SoP a set of eight principles were published by the government outlining the vision for flood insurance:

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.

The proposed scheme, 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’. However, the ‘value for money’ aspect of this is highly debatable as the scheme does not meet the minimum government standard for cost-benefits. The lack of risk reduction is clear as it does not feature in the official proposal other than in the supporting Memorandum of Understanding, which sets out the government’s commitment to flood risk management and joint efforts to improve flood risk data.

Roles and responsibilities of partners

In the UK, private insurers cover all aspects of insurance provision while the UK government determines and delivers flood risk management. More specifically, flood management responsibility, policy and legislation for England are determined by the Department for Environment, Food and Rural Affairs with national flood and coastal erosion management delivered by the Environment Agency. Local authorities have lead responsibility for managing local flood risk, which includes surface water runoff, groundwater and ordinary watercourses, and are designated as Lead Local Flood Authorities.



Under the SoP flood insurance is provided by private insurers while government commits to investment in flood defences and improved flood risk data provision as well as a strengthened planning system. Compliance with the agreement is assessed on an annual basis by both sides – with insurers providing details of flood insurance provision and declined cover and government releasing flood defence spending numbers, flood risk data and updates on the performance of the planning system. While this allows for a degree of public scrutiny, the main corner stone of the SoP is mutual interest in a functioning private flood insurance system. The agreement deals with availability of cover, while pricing and terms and conditions are not affected by the SoP, and it allows for cross subsidisation between those households and businesses at differing levels of risk.

The most visible aspect about the government's commitment to the SoP is the amount spent on building and maintaining flood defences. Over the period 2010-2011, the total budget for the EA was £800m, £570m of which (71%) was spent on building and maintaining flood defences. To integrate the change in risk, investment levels for flooding and coastal erosion will need to increase to account for the effects of climate change. The EA's long term strategy states that £1040 million a year plus inflation is needed until 2035 for building and maintaining new and existing flood and coastal risk management if current protection levels are to be maintained. This figure is an increase of around 80% on 2010-2011 levels and excludes the costs of managing the risk of surface and groundwater flooding.

Evidence for any assessment of 'four variables' (commercial viability, financial sustainability, affordability, and vulnerability reduction):

To determine the financial limits, scope, and to compare the alternative approaches to Flood Re as well as Flood Re itself, the UK government conducted an impact assessment on the four potential preferred options of flood insurance provision in the UK (Defra, 2013b). All costs are based on 2013 figures and are used to compare the alternative options against a baseline of a 'do minimum approach' which assumes an immediate transition to risk reflective pricing for all at risk households, but does assume there is encouragement of industry measures and the setting up of a local authority community resilience fund.

The main focus of Flood Re (Option 2: 'A subsidised insurance pool for high-risk properties') is on the affordability and availability of insurance to high risk households, with households entering the scheme if they meet a particular risk threshold. This approach ensures affordability through capping the costs of premiums based on council tax banding (See page 16, Defra, 2013). This gradually moves to risk reflective pricing over a period of 25 years, although the exact details of how affordability will be met at the end of this timescale has yet to be determined. Low to medium risk households will not be eligible for the scheme and enter the free market for flood insurance (although continuing to buy a household policy as normal with bundled flood insurance).

This approach guarantees that the scheme will have an already established pool of entrants (expected to be approximately 356,000 high risk households) ensuring there is the demand aspect required for an insurance scheme to operate. However the government acknowledge that Flood Re does not meet its own value for money' criteria 'but states there are wider socio economic reasons for choosing this approach that go beyond a straightforward financial analysis. The design of the Flood Re scheme, however, has not taken into account adequately the change in flood risk over time, particularly in respect to climate change. It may therefore be likely that Flood Re is put under increasing pressure and may prove to be unsustainable because the number of properties in future that will be at moderate and high probability of flooding has been significantly underestimated.





Another key aspect in maintaining this scheme is the cross subsidy of all policyholders which will fund Flood Re, equating to £180m per annum (Defra, 2013b). The scheme also uses commercial reinsurance, allowing some sustainability if the pool is subject to a deficit in the event of a large flood. In the event of a flood, if the threshold to trigger reinsurance pay-outs is not met but costs are more than the pool holds in funds, Flood Re will be additionally supplemented by payments from insurers. It has yet to be seen how exactly this will work and how often the pool will be subject to pay-outs. In this respect the first several years of Flood Re will determine its financial sustainability although it is noted that a review of the transition over 25 years will be conducted every five years.

Vulnerability reduction under the scheme is limited. Very little consideration is given as to how the scheme will operate alongside risk reduction measures, both in relation to how flood risk management measures will be targeted in high risk areas and how the insurance scheme incentivises individuals to take up resilience and resistance measures. The existing scheme, governed by the Statement of Principles on the Provision on Flood Insurance, provided links between flood insurance and spending on flood defences, improvements in planning regulations, and access to flood risk information. It is not clear whether the new Memorandum of Understanding (for Flood Re) between the Government and insurance industry will act to ensure continuation and importantly progression on these links.

