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# Insurance of weather and climate-related disaster risk: Inventory and analysis of mechanisms to support damage prevention in the EU

Final report

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RAMBOLL

VU VRIJE UNIVERSITEIT AMSTERDAM

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*Contact:* Max Linsen

*E-mail:* Max.LINSEN@ec.europa.eu

*European Commission*
*BE-1049 Brussels*

# Insurance of weather and climate-related disaster risk: Inventory and analysis of mechanisms to support damage prevention in the EU

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| Date | **31 August 2017** |
| Made by | **Xavier Le Den, Matilda Persson, Audrey Benoist (Ramboll)**<br>**Paul Hudson, Marleen de Ruiter, Lars de Ruig, Onno Kuik (IVM)** |
| Checked by | **Christian Nyerup Nielsen (Ramboll)**<br>**Wouter Botzen (IVM)** |
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## EXECUTIVE SUMMARY

Ramboll and the Institute for Environmental Studies (IVM) were contracted by the European Commission (EC) to conduct a study on the insurance of weather and climate-related disaster risk, and to create an inventory and analysis of mechanisms to support damage prevention in the European Union (EU). The study provides an overview of the use of insurance against natural disasters. It suggests general recommendations as well as specific recommendations on the role of the European Commission in addressing the issues uncovered, and encourages stakeholder's efforts and best practices observed across the EU.

### *Objectives of the study*

The study builds on the EU Adaptation Strategy (EC, 2013a) and the Green Paper on the insurance of natural and man-made disasters (EC, 2013b), and addresses the objective of encouraging the use of insurance to manage weather and climate-related disaster risk. More specifically, the study supports the EU Adaptation Strategy through: (1) Increasing the knowledge base by collecting and providing information with regards to insurance coverage, mechanisms and cost-effectiveness, including preventive capacity; (2) Increasing awareness, promoting further action and defining the next steps in insuring extreme weather events.

### *Methodology*

The study consists of the following tasks: (1) Stock-taking of insurance mechanisms covering weather-related disaster risks, applied in (and beyond) the EU, (2) Analysis of the cost-effectiveness of insurance mechanisms, including preventive capacity and an analysis of which mechanisms incentivise prevention of risk and support damage reduction, and (3) Definition of next steps in insuring weather and climate-related extreme events.

In Task 1, 12 case study countries were selected, based on a comprehensive overview of all EU countries of weather-related insurances for different sectors and perils (i.e. floods, droughts and windstorms), as well as the following criteria: geographical balance, wide coverage of extreme weather events, coverage of different styles of insurance provision, coverage of different sectors and data availability. The criteria were assumed to ensure that the conclusions from the 12 case studies could also be applied to the Member States not selected. The countries studied were: Bulgaria, Denmark, Germany, Spain, France, Italy, Hungary, Austria, Poland, Romania, Sweden and the United Kingdom.

Task 2 defined and assessed the cost-effectiveness of insurance mechanisms, including their preventive capacity. Firstly, the cost effectiveness of weather-related insurance mechanisms was determined, and secondly, mechanisms that incentivise prevention of risk and support damage reduction were analysed. For each natural disaster type, a systematic literature review was conducted and supported by stakeholder surveys and data obtained from EM-DAT[1], NatCatService[2] and Sigma[3] datasets. In addition, on a policyholder level, information on existing and innovative adaptation measures was collected per hazard type. The final views on the cost-effectiveness of insurance were judged by comparing qualitative or quantitative outcomes against what various stakeholders consulted in this study viewed as the most important criteria for insurance: to perform well. This culminated in a multi-criteria analysis (MCA) of the selected national insurance schemes in the private property and agriculture sectors.. The commercial sector was not selected for this MCA due to a lack of available data and because it shares similarities in insurance provision with the private property sector.

[1] http://www.emdat.be/

[2] https://www.munichre.com/en/reinsurance/business/non-life/natcatservice/index.html

[3] http://institute.swissre.com/research/overview/

The MCA framework was based on five evaluation criteria: insurance penetration rates, risk signalling and risk reduction incentives, the affordability and availability of insurance, the speed of payments, and the overall solvency of the insurance mechanism. Using the MCA, elements of cost-effectiveness of weather-related insurance schemes for private properties and agriculture that are present in the 12 selected case study countries were assessed and evaluated. Thereafter, it focused on the cases that scored the top two highest scores for a given MCA weighting scheme.

The weighting schemes were defined by different risk management objectives. For example, the same insurance product may fulfil a policy objective related to solidarity and coverage, while it does not score well from the point of view of risk management. The three key objectives studied were based on: Weighting scheme 1: solidarity and coverage; Weighting scheme 3: ability of insurance to act as an adaptation signal or risk management incentive; and an intermediary scheme, Weighting scheme 2: insurance as a private good, balancing the different objectives of the relevant stakeholders.

Conclusions from taking stock of the innovative approaches and the case studies fed into Task 3. A questionnaire was circulated to stakeholders within the case study countries to generate their views regarding future natural disaster insurance and how this can support damage prevention. Parallel to the case studies and throughout the project, interviews with a broad range of stakeholders were conducted. This was done to ensure that the analysis for the next steps goes beyond the case studies, and that viewpoints from the different types of stakeholders are taken into consideration. In order to get detailed feedback on the findings on the case studies as well as the next steps, a focus group of recognised experts was formed, which held two meetings. A final event with 80 participants, representing a broad range of stakeholders, provided an opportunity to communicate the results and recommendations of the study, and to receive valuable feedback.

***Main findings of the study***

An examination of a combination of available loss datasets for the selected European cases shows it is not yet very clear whether there is an increase in monetary impacts from extreme weather events. The key loss drivers are increases in wealth in general, and increased exposure of assets and infrastructure in hazard-prone areas (EEA, 2017). The effect of climate change is by comparison more difficult to determine due to the natural variability of natural hazards and often unobserved changes in vulnerability, especially when the data used is primarily focused on monetary values. Under most climate change scenarios, the intensity and frequency of extreme weather events will increase in the future. This implies that probably the damage costs will also increase, unless more proactive disaster risk management measures are taken. This is a key argument for policy-makers and other actors within countries and the Commission involved in adaptation policies and actions, including insurance mechanisms, to take note (EEA, 2017; Kurnik, 2017).

The risk profile across the case studies and by extension across the EU is changing towards a situation where extreme weather events are becoming more common, with an overall increase in risk. This will place an increasing burden on the budgets of policyholders, insurers and governments alike to absorb these impacts.

Insurance has attracted much policy attention as a tool for building resilience to extreme weather events by providing financial compensation for losses and incentives to reduce risk. Insurance companies share financial risk across policyholders, and risk-based premiums can incentivise individual policyholders to reduce risk (Hudson et al., 2016). However, insurance becomes less attractive for high-risk households when premiums reflect the underlying risk

(Botzen et al., 2009a). Although lower risk policyholders have a weaker incentive to reduce risk, they are more likely to buy insurance since premiums are more affordable.

This trade-off between premium affordability and risk-reduction incentives is an important, yet difficult, challenge for insurance companies to balance, and is often influenced by different risk management objectives (Kunreuther, 1996; Botzen et al., 2009b; Kunreuther and Michel-Kerjan, 2009; Mechler et al., 2014; Penning-Rowsell and Pardoe, 2012; Surminski and Oramas-Dorta, 2014). The differing risk management objectives of the stakeholders show that there would be room for more open and transparent engagement of, and collaboration with, the various stakeholders involved in the risk management process.

**On the whole (across extreme weather events), insurance at affordable rates, notwithstanding individual deviations from this, is available in the countries studied.** Despite the relatively good performance, there is still room for improvement. In the private property sector the two main problems to overcome are insuring localised disasters, such as flooding, and promoting households to buy insurance (the two may be interconnected). These two aspects are reflected in low private property insurance penetration rates. Households either do not fully acknowledge the benefits of being insured against extreme weather or their willingness to pay is lower than the premiums charged.

**Generally, the countries studied do not perform very well in terms of providing incentives for risk reduction or signalling the risk**. This comes from the overall reliance on deductibles or awareness campaigns for achieving risk reduction. These incentives provide indirect risk management signals. Awareness campaigns aim to readjust risk perceptions by increasing the perceived benefits of risk management. However, unless there are constant campaigns, views are likely to revert after the campaign is concluded. Deductibles by themselves are also unlikely to incentivise risk reduction (*ex-ante*) because unless an extreme weather event occurs the deductible doesn't provide a tangible incentive for the policyholder to act upon.

There are several reasons why this relative lack of focus on risk reduction has occurred. The first corresponds to **the market's focus on providing widespread or affordable coverage**, which can reduce the focus on risk reduction. A second barrier is the **combination of the indemnity principle** (i.e. the insured is compensated for what is lost) **and competition between insurers**. This can limit the extent to which insurers offer incentives or requirements for risk reduction as customers could instead take a policy with less stringent conditions. A third reason is that there could be **information asymmetries or transaction costs** that hamper offering tangible incentives (such as premium discounts) for a wide range of potential risk-reduction measures. The costs of monitoring the employment of such measures could be expensive. A final barrier can be seen as the **lack of transparency in insurance premiums**. It is quite common for insurance to be provided as a bundle of risks. This makes it difficult for a policyholder to identify the part of the premium that is charged for specific extreme weather risk and to know the degree of risk sharing across the insured population.

Tables 1 and 2 highlight the consistent characteristics of insurance in the best performing countries per sector. This provides an indication of the general features of a market that can be considered to be best practices, and highlights areas to focus upon.

*Table 1: Summary of features leading to high or low performances in the private property sector*

| High-performing | Low-performing |
|---|---|
| • Multiple extreme weather risks are combined in a single policy | • Extreme weather risks are separately insured |
| • Purchase of extreme weather insurance is connected to a far more commonly required and enforced product (e.g. mortgage contracts, fire insurance) | • Lax enforcements of requirements to buy insurance |
| • Collaboration between public and private sectors with a commonly stated and understood objective<br><br>This can be seen as a contract between the insurance sector and the government, whereby each group takes actions that maintain the provision of insurance coverage. | • Low overall insurance coverage |
| • Provision of a national pool or public reinsurance / support for catastrophic losses | • Consumers are reliant on direct public compensation for extreme weather event losses |

*Table 2: Summary of features leading to high or low performances in the agriculture sector*

| High performing | Low performing |
|---|---|
| • The use of multi-risk insurance (with a focus on yield insurance) | • Only specific weather-event insurance products are available |
| • Requirements to insure all cultivated land | • Only land with a specific crop must be insured |
| • Premium subsidies to direct investment in multi-risk policies | • The presence of ad-hoc government compensation not tied to insurance coverage in the case of truly extreme events |
| • Pool-like structures or public reinsurance for systemic risks, such as droughts | |
| • A tradition of collaboration between the public and private sector risk managers | |

***Recommendations***

Policy suggestions to overcome these barriers can come in many forms, and the stakeholder consultation highlighted several policy strategies to overcome them, which are listed below.

A first one could be to place the responsibility for promoting and developing risk reduction strategies into the hands of an external body that collaborates with insurers. The exact nature of such an external body is difficult to determine *a priori* across countries; however, such an organisation can operate directly or indirectly at various national levels (i.e. national, regional or city level). For instance, a national body can produce investments in prevention strategies or larger scale risk-reduction strategies. These actions could facilitate a national minimum level of risk management and insurance viability, upon which more localised bodies or agents can act. For example, a city can collaborate with insurers to better manage their risk beyond this minimum level imposed by the external body. It is difficult to determine or propose a uniform structure for such an organisation because EU Member States have varying levels of autonomy for cities or regions. Financial capacity for risk-reduction investments can be created by adding a surcharge to insurance premiums into a fund that uses the money raised to construct protection and other large-scale adaptation measures, or to subsidise more individual-level measures. Potential advantages of such a premium surcharge compared with financing from general taxation is that such funds are earmarked for risk reduction, and that the surcharge acts as a signal of risk if premiums are at least partially risk-based. This fund can be a not-for-profit management entity in which insurers, government agencies and other stakeholders are involved. Moreover, such a management entity could be mainstreamed into a country's overall climate change adaptation strategy.

The second one is the improved use of insurer's data and knowledge in developing zoning and building code regulations and construction requirements. Insurers often have good information on which areas are at high risk and which building-scale measures can lower risk, which is important information for government authorities to use in designing zoning and building code regulations. An advantage is that such measures are structural, which may limit information asymmetries that could arise with non-structural measures that policyholders may take only temporarily.

The third is to reconsider regulations that require policyholders to use insurance reimbursements after a disaster for reconstructing their property to the same state as before the disaster occurred. Introducing 'build back better' requirements could allow the recovery and repair process to build risk-reduction measures directly into buildings when awareness of the impacts of extreme weather events is strongest.

Recommendations derived from the study have been grouped into five themes: promote risk awareness and reduction; closing the protection gap; the role of public and private entities in the risk cycle; the role of cities and regions; and integration of resilience, including insurance data, in relevant policies. It should however be noted that the recommendations are in many cases cross-cutting and can cover several themes. Table 3 summarises the broader recommendations.

***Table 3: List of recommendations to the stakeholder community***

| **Sector** | **Theme and recommendation** |
|---|---|
| | **Promote risk awareness and reduction** |
| Private property | Low-income (following local definitions of low income or social hardship) households struggling to afford extreme weather insurance should have this pressure eased with insurance vouchers or tax credits if they buy insurance coverage. |
| | Minimum building standards, or build-back-better requirements, differentiated by risk levels can be required as a standard element of insurance contracts in order to gain coverage (with a focus on measures integrated into the building). |
| Multi | Research with the aim of defining and quantifying resilience to support risk awareness and reduction, and a focus on how insurance can enhance the economic resilience. |

| | **Closing the protection gap** |
|---|---|
| Private property | Promote the bundling of a complete extreme weather event insurance package with private property fire insurance policies (or a similar and often purchased product). |
| | Urge banks to require full and comprehensive insurance coverage when providing mortgage loans. |
| Agriculture | Redirect premium subsidies towards multi-peril (yield) crop insurance products to provide more extensive coverage. Each extreme weather event can contribute to the overall premium in line with its risk level. |
| | In order to reduce the presence of adverse selection in crop insurance and only insuring the high-risk land, a farmer should be compelled to insure all arable land as part of the terms and conditions of an insurance policy. |
| | Link access to wider agricultural sector subsidies (i.e. those relating to the common agricultural policy (CAP) or those offered at national level) to the purchase of sufficient insurance protection in order to develop a tradition of being insured. |
| | Support the use of farm income insurance by starting pilot initiatives in various Member States. |
| | **Support public-private partnerships (PPPs) and cross-organisational collaboration** |
| Private property | Use a surcharge on insurance premiums (either newly introduced or redirected current taxes) to directly finance and construct risk-reduction infrastructure or to directly subsidise household level risk-reduction measures. |
| | Create a national focal point or authority for developing and maintaining a legal framework through which extreme weather risks can be managed via a combination of risk reduction and/or transfer. |
| | Lay down the roles and responsibilities of all the stakeholders in a national platform, focal point or authority, in a clear and transparent framework. |
| Agriculture | Develop an agricultural risk management association with a focus on protecting farmers against income variations due to crop yields, within a mutual or non-profit maximising organisation. |
| Multi | Create a working group in the European Commission enabling cross-Directorate-General (DG) collaboration, as well as coordination with national bodies. |
| | **Increase the role of cities and regions** |
| Cities and regions | Recommend cities assess their vulnerability in regard to insurance penetration rates, including for municipal infrastructure and extreme weather events covered, as well as reporting on how they use insurance as a mechanism for managing risks. |
| Cities and regions | Promote the use of insurance disaster loss data in the municipalities' risk-assessment data. |
| | Promote the active and collaborative sharing of risk, hazard and impact data across stakeholders though the standardisation of metadata and the format of granular data that can be more efficiently and transparently shared across stakeholders productively. |
| Cities and regions | Promote the use of community rating systems for setting premiums |
| Cities and regions | Promote the spreading of risk by allowing cities to pool their insurance |
| Cities and regions | Increase capacity building with regard to insurance and climate resilience |

| | **Integration of resilience, including insurance data, in relevant policies** |
|---|---|
| Member States | Introduce a requirement for flood risk management plans, national adaptation strategies and applications for loans or national or EU funds to include insurance mechanisms for managing risk that cannot be (cost-) effectively prevented in order to further mainstream insurance into national adaptation conversations. |

The table below is based on the general recommendations presented previously but lists the specific recommendations to the European Commission with the aim of being in line with their mandate and role.

***Table 4: List of recommendations to the European Commission***

| # | Recommendation |
|---|---|
| Recommendation 1 | Increase the requirements or recommendations for Member States to assess their vulnerability in regard to insurance penetration rates and events covered, as well as to report on how they use insurance as a mechanism for managing risks. |
| Recommendation 2 | Include an *ex-ante* conditionality for the European Structural and Investment Funds on assessing insurance vulnerability and the usage of insurance as a risk management tool. Strengthen reporting requirements in EU funding applications. |
| Recommendation 3 | Fund a study with the aim to define and quantify resilience at EU level with a focus on how insurance can enhance economic resilience. |
| Recommendation 4 | Promote the use of insurance mechanisms that will support damage prevention to Member States.<br><br>Promote the bundling of a combination of extreme weather events with private property fire insurance policies (or similar purchased product).<br><br>Inform stakeholders about the potentials of low-income households receiving subsidies for insurance in the form of insurance vouchers or tax credits if they buy insurance coverage.<br><br>Foster discussions in relevant forums about minimum building standards or build-back-better requirements (after events), differentiated by risk levels, which may be required as a standard element of insurance contracts in order to gain better coverage. |
| Recommendation 5 | Increase the proportion of funds to the second pillar of the CAP, focused on the risk-management toolkit, including insurance schemes for crops, animals and plants, as well as mutual funds and an income stabilisation tool. At a national level, the following conditions should be considered:<br><br>- Redirect premium subsidies towards multi-peril (yield) crop insurance products to provide more extensive coverage. Each extreme weather risk can contribute to the overall premium in line with the threat posed by each extreme weather risk;<br><br>- In order to reduce the presence of adverse selection in crop insurance, a farmer could be compelled to insure all arable land as part of the terms and conditions of an insurance policy; |

| # | Recommendation |
|---|---|
| | - Introduce farm income insurance as a potential tool through a pilot project. |
| Recommendation 6 | Support and facilitate the creation of a national focal point or authority for developing and maintaining an institutional and legal framework through which extreme weather risks can be managed via a combination of risk reduction and transfer.<br><br>Support and facilitate an agricultural risk management association with a focus on protecting farmers against income variations due to crop yields (i.e. supporting multi-risk yield insurances or the employment of risk-reducing measures) within a mutual or non-profit maximising organisation. |
| Recommendation 7 | Create a working group in the European Commission that enables cross-DG collaboration, awareness raising and stakeholder collaboration, as well as coordination with national bodies. |
| Recommendation 8 | Fund projects with the aim to increase the capacity of cities in order to use insurance as a risk management tool and insure infrastructure. |
| Recommendation 9 | Create a dialogue between the insurance industry, municipalities and national bodies on how community rating systems and the pooling of city insurance can be developed |

# 1. INTRODUCTION

Ramboll and the Institute for Environmental Studies (IVM) of the Vrije Universiteit (VU) Amsterdam were contracted by the European Commission to study the insurance of weather and climate-related disaster risk, and to create an inventory and analysis of mechanisms to support damage prevention in the EU.

## *1.1 Background*

The impacts of natural hazards have increased over recent decades in several regions around the world (Bouwer, 2011) and extreme weather events are a pressing global concern (IPCC, 2012, 2014). As an example, flooding is regarded as the natural disaster with the largest impact on humanity (UNISDR, 2011; Swiss Re, 2015). In May 2015, floods in the USA caused USD 2.7 billion in damage, while the December 2015 floods across the United Kingdom, Ireland and Norway resulted in between USD 1.6 bn and 2 bn in damage (Munich Re, 2015; Swiss Re, 2016). Europe has suffered an annual average loss of USD 14bn between 1980 and 2010, due to the effects of extreme weather events (NMI, 2013).

Climate change is expected to increase the frequency and intensity of some weather-related disasters in Europe and elsewhere (IPCC, 2012, 2014). The economic impacts of weather-related disasters are expected to increase significantly due to the combined effect of climate change and socio-economic developments, such as economic growth, increased urbanisation and population growth in areas that are prone to disasters. Therefore, there is a growing need to enhance resilience to natural disasters and improve climate change adaptation mechanisms. To minimise the effects of natural disasters, pro-active management is required, as noted in the Sendai Framework for Disaster Risk Reduction for the period 2015-2030 (UNISDR, 2015a). One of the key priorities of the Sendai framework is to improve societal resilience (Mechler, 2016). While often contested (see e.g. Klein et al., 2003; Bockorjova, 2007; Rose, 2007), definitions of resilience tend to focus on a quick recovery from the impacts of a disaster event at low cost. The Sendai framework, therefore, encourages the use of instruments that finance recovery costs while offering incentives to reduce the potential impacts of weather-related disasters (Mysiak et al., 2016).

In 2013, the EU presented its Adaptation Strategy (EC, 2013a), which outlines objectives and actions to contribute to a more climate-resilient Europe. The three objectives are as follows:

1. Promoting action by Member States;
2. Promoting better informed decision making ; and
3. Promoting adaptation in key vulnerable sectors.

The third objective, promoting adaptation in key vulnerable sectors, encourages the use of insurance against natural and man-made disasters. This is set out in Action 8 in the strategy, which is to promote insurance and other financial products for resilient investment and business decisions. The Green Paper on the insurance of natural and man-made disasters (EC, 2013b) was adopted as part of the Adaptation Strategy package in 2013. The objective of the Green Paper was to encourage improvement in the way insurers help to manage climate change risks, to improve the market penetration of natural disaster insurance and to unleash the full potential of insurance pricing and other financial products.

The EU recognises that disaster risk insurance is an important element for climate adaptation since it does not only support risk sharing but is working throughout the risk management cycle (identify, analyse, plan, implement and evaluate) and the disaster management cycle (prevent and protect, prepare, respond and recover).

In the European Commission's Action Plan on the Sendai Framework for Disaster Risk Reduction 2015-2030 (EC, 2016) the importance of insurance is highlighted in Implementation Priority no 15 under key area 3: promoting EU risk-informed investments (Sendai Priority 3: Investing in disaster risk reduction for resilience), which is to promote the use of mechanisms for disaster risk financing, risk transfer and insurance, risk sharing and retention. The study under which this report is prepared falls under activity 15.1 mentioned in EC (2016), which calls for a high-level round table with the insurance sector and relevant EC services to explore how to strengthen the use of risk financing, risk transfer and insurance products as an incentive for risk awareness, prevention and mitigation as a follow-up to the Green Paper.

### *1.2 Purpose of this study*

The present study builds on the EU Adaptation Strategy and the Green Paper on the insurance of natural and man-made disasters, and addresses the objective of encouraging the use of insurance against natural and man-made disasters. More specifically, the study will support the EU Adaptation Strategy through the following:

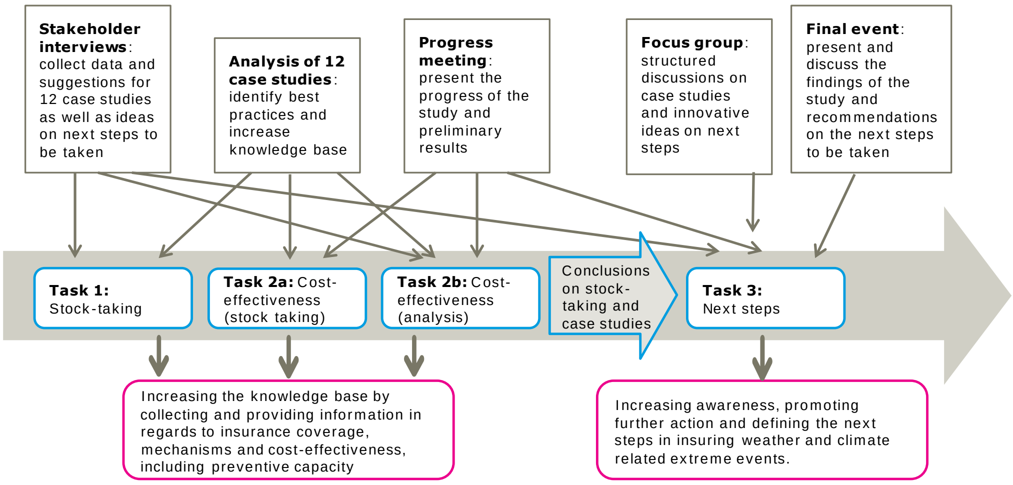
1. Increasing the knowledge base by collecting and providing information with regard to insurance coverage, mechanisms and cost-effectiveness, including preventive capacity;
2. Increasing awareness, promoting further action and defining the next steps in insuring weather and climate-related extreme events.

To this purpose, the study consists of the following tasks, as defined in the tender specifications of the project:

- **Task 1:** Stock-taking of insurance mechanisms covering weather and climate-related disaster risks, applied in (and beyond) the EU;
- **Task 2:** Analysis of the cost-effectiveness of insurance mechanisms, including preventive capacity;
    - Task 2a: Determining the cost-effectiveness of insurance mechanisms;
    - Task 2b: Analysis of the mechanisms that incentivise prevention of risk and support damage reduction;
- **Task 3:** Definition of the next steps in insuring weather and climate-related extreme events.

The tasks are applied to 12 case studies and various research activities; for example, data collection, stakeholder engagement and literature reviews have been used. Figure 1.1 below provides an overview of the study objectives, tasks and research activities.

***Figure 1.1: Overview of the study objectives, tasks and research activities***



### 1.3 Methodology

As part of Task 1, a literature review was conducted to create an overview of insurance mechanisms covering weather-related disaster risks for EU countries in order to produce the attribute tables with characteristics of these mechanisms that are displayed in Appendix 2. Rather than using company or policy levels, the national scale has been selected as an appropriate level of analysis. The national scale is often used in academic literature investigating insurance market structures (e.g. Paudel et al., 2012; Lamond and Penning-Rowsell, 2014), it has been used by previous EC reports regarding various aspects of insurance (e.g. Diaz-Caneja et al., 2009; Maccaferri et al., 2012) and is most applicable to the objectives of this study.

Task 2 assesses the cost-effectiveness of insurance mechanisms, which is defined to include their preventive capacity, among other characteristics. Firstly, the cost-effectiveness of extreme weather insurance mechanisms is determined; secondly, the mechanisms that incentivise the prevention of risk and support damage reduction are analysed. For each natural disaster type, a systematic literature review has been conducted, which is supported by stakeholder surveys and data obtained from EM-DAT, NatCatService and Sigma datasets.

On a household level, information on existing and innovative adaptation measures has been collected per hazard type. The final views on the cost-effectiveness of insurance are judged by comparing qualitative or quantitative outcomes against what various stakeholders consulted in the study view as being the most important criteria for insurance: to perform well. This is similar to a multi-criteria analysis.

Task 3 defines the next steps in insuring weather-related extreme events. Conclusions from taking stock of the innovative approaches and the case studies will feed into Task 3. Moreover, there is a section in the questionnaire that was circulated to stakeholders within the case study countries to gather their views regarding future natural disaster insurance and how this can support damage prevention. Answers were collected in writing and via interviews. Parallel to the case studies and throughout the project progress, interviews with a broad range of stakeholders were made in order to ensure that the analysis for the next steps forward goes beyond the case studies. Furthermore, viewpoints from the different types of stakeholders were taken into consideration. In order to get detailed feedback on the findings from the case studies as well as the next steps, a focus group was formed and two meetings were held (one in person and one webinar). A final event with 80 participants representing a broad range of stakeholders was held, which ensured that feedback from a wide range of stakeholders was received on both the results and the recommendations of this study.

# 2. PAST AND FUTURE EXTREME WEATHER LOSSES

The purpose of the present chapter is to provide an overview of past (1990-2015) and projected (2030-2050) extreme weather-related losses and their potential drivers for the case study countries as requested by the project's specifications (Task 1). This chapter explores this through a semi-qualitative analysis of extreme weather loss data and examples from the wider literature.

The chapter consists of a section discussing observed losses from the extreme weather events that can be considered as natural disasters (section 2.1). The methodological approach for the first sub-sections is a simple trend analysis of non-normalised and normalised disaster losses aggregated across case study countries and extreme weather events (see the suggestion to use normalisation from EEA, 2017 among others). Section 2.2 presents a discussion of the projected changes in extreme weather risks, which is supported by section 2.3, which provides a discussion of the main drivers of changing extreme weather risk. The methodological approach taken for section 2.2 and section 2.3 is a review of the scientific and grey literature on the topic.

## *2.1 Observed losses between 1990 and 2015*

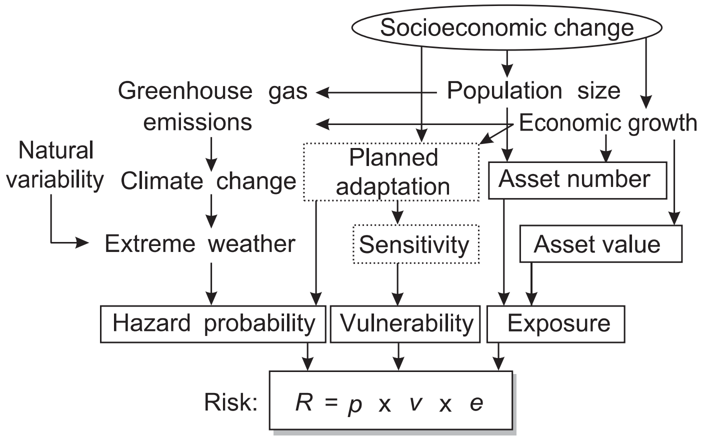
As part of the stakeholder engagement, it was asked which extreme weather events the stakeholders found most important. From the point of view of the engaged stakeholders (mainly insurers, see Appendix 3), we received an indication of the perceived importance of the various extreme weather events studied; i.e. which extreme weather event is the most important in their opinion. Their current ranking is as follows: pluvial and fluvial flooding, windstorms, coastal flooding (for non-landlocked countries), droughts, heatwaves and hail. Pluvial flooding is indicated as the most important disaster because it is generally deemed to be an underrated extreme weather event. It is underrated in the sense that even compared to other types of flooding, the risk perception of potential policyholders is low. Therefore, pluvial flooding may become a more pressing concern if urban areas are not correctly adapted to cope with the predicted increase in precipitation intensity (IPCC, 2012). This finding may apply more widely to the various extreme weather events studied if the perception of risk is not in line with the actual development (IPCC, 2014).

The engaged stakeholders also indicated which sector is most affected by each extreme weather event. It emerges from the process of stakeholder engagement that the private property and commercial sectors are most affected by the various types of flooding and windstorms, and the agriculture sector is the most affected by heatwaves, droughts and hail.

**Box 1 Framework for modelling risk from extreme weather events**

The impacts of extreme weather events are often evaluated based on their risk, consisting of three elements: exposure, vulnerability and hazard (Kron, 2005). Exposure is the value of assets and the population exposed to extreme weather events; vulnerability is the susceptibility to damage; and hazard is the extent and intensity of the disaster event itself. Current and future impacts are often modelled according to the risk framework as presented in this box. The modelling framework expresses risk as the probability weighted average impact of all possible events. The figure in this box highlights that the assessment of current and future impacts is influenced by several long chains of intervening concepts, providing many sources of uncertainty or areas to target for risk reduction.

**Framework for modelling risk from extreme weather events (from Bouwer, 2013)**




The number of extreme weather events and monetary impacts for the selected case studies can also be estimated by using the following datasets: EM-DAT, NatCatService and Sigma. The data for the case study countries not only cover a wide geographical spread, but also cover a substantial proportion of the observed data across the three studied datasets. Over the period 1990-2015, the ensemble average number of extreme weather events within the 12 case study countries is on average 75 % of the events in Europe, while covering about 90 % of the recorded monetary losses in Europe. Therefore, the case studies produce a representative view of the raw data available. It must be noted that each database had varying rules for an extreme weather event to be included in the dataset. This could produce an incomplete view of extreme weather events in total, but a more representative view of disastrous events (as variously defined). For example, EEA (2017) states that more than 70 % of the damage suffered was caused by of 3 % of the registered events (using the NatCatService database).

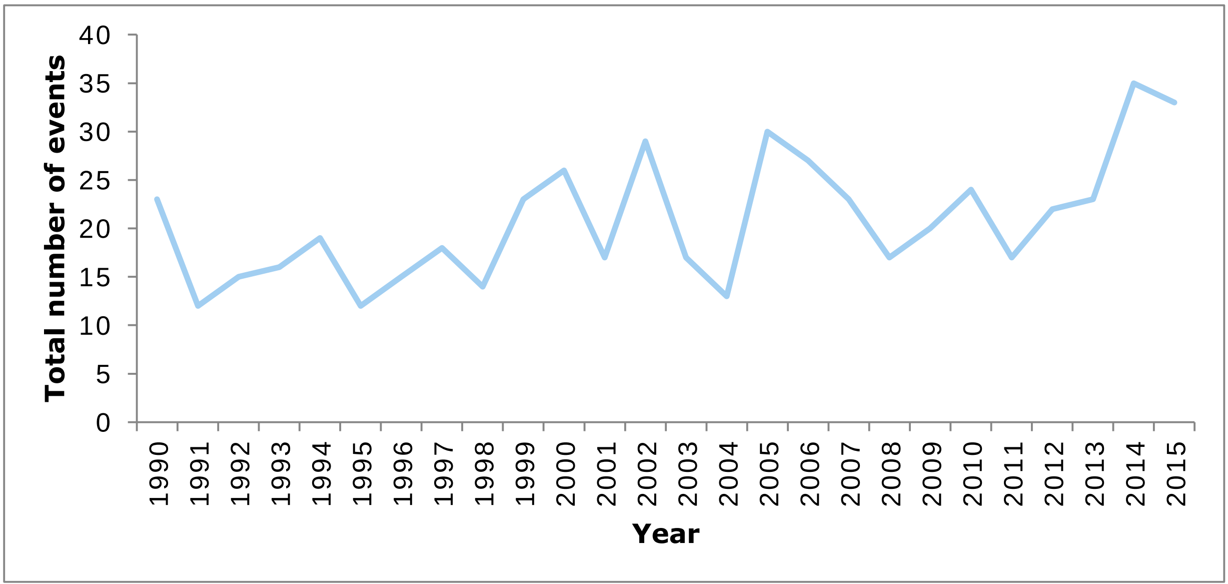
Following the approach taken in the annual catastrophe reports on global natural disaster losses of Munich Re and Swiss Re (e.g. Munich Re, 2015; Swiss Re, 2016), we aggregated national observations to their totals within a specific year (i.e. all extreme events in Sweden in 2010). Moreover, there is a degree of uncertainty in the datasets between the recorded number of events and the specific impact. We shall therefore present the dataset ensemble average of the values reported in the three datasets used.

### *2.1.1 Total monetary losses*

*Observed impacts from natural disaster databases (EM-DAT, NatCatService and Sigma) for the years 1990 to 2015*

Figure 2.1 presents the dataset ensemble average number of reported extreme weather events (that can be considered as disasters) and indicates a slight upward movement in the number of reported events over the period studied. The degree of annual volatility in impacts is clearly visible in Figure 2.1, but it is difficult to spot a trend in losses across these countries and disasters (individually) due to the variability of losses. This would be expected because natural disasters are low-probability/high-impact events in specific regions. However, there may be a reporting bias over time as reporting has improved. While this is a concern, Kron et al. (2012) argue that (for NatCatService at least*)* reporting bias may be fairly minor after 1980.

***Figure 2.1: Aggregated number of disastrous extreme weather events across the 12 case study countries (the ensemble average across the three datasets)***




However, the number of disaster events itself does not provide a full picture of the impacts of disastrous extreme weather events on society as a whole. Figure 2.2 presents the sum of aggregated disaster losses for the 12 case studies, corrected for inflation and when normalised, from a range of extreme weather events. The normalisation process can be useful for comparing impacts of disaster events over time, due to changes in socio-economic and climate conditions that determine disaster impacts. Equation (1) shows the normalisation process based on Neumayer and Barthel (2011), which accounts for inflation, population and wealth changes.

$$Loss_{i,t}^{Normalised,2015} = \frac{wealth_{i,2015}}{wealth_{i,t}} \frac{population_{i,2015}}{population_{i,t}} \frac{GDP\ deflator_{i,2015}}{GDP\ deflator_{i,t}} Loss_{i,t} \qquad (1)$$

Figure 2.2 presents the aggregated normalised and inflation-corrected losses across the disastrous extreme weather events and case study countries studied, with 2015 as the base year. The inflation-corrected losses do not display a consistent trend in either falling or increasing disaster impacts due to the large volatility in total recorded impacts. However, the normalised disaster loss data indicates a slight decreasing trend in disaster losses if all data points are included, but this trend is not robust as excluding 1990 eliminates this trend. This trend can appear to be different to those presented in reports such as Munich Re (2015) or Swiss Re (2016), which is likely because our focus is only on 12 countries within the EU while the aforementioned studies take a more global perspective. The global perspective can include areas where exposure is growing faster than changes in vulnerability, resulting in a net increase in potential losses. Figure 2.3 presents the average inflation-corrected or normalised loss on average per event. The inflation-corrected losses do not present a strong trend, similar to the findings as presented in EEA (2017). The average normalised losses per event are (slightly) more robust than the results presented in Figure 2.2.

***Figure 2.2: Normalised and inflation-corrected disaster losses aggregated across the 12 case study countries (EUR billion)***

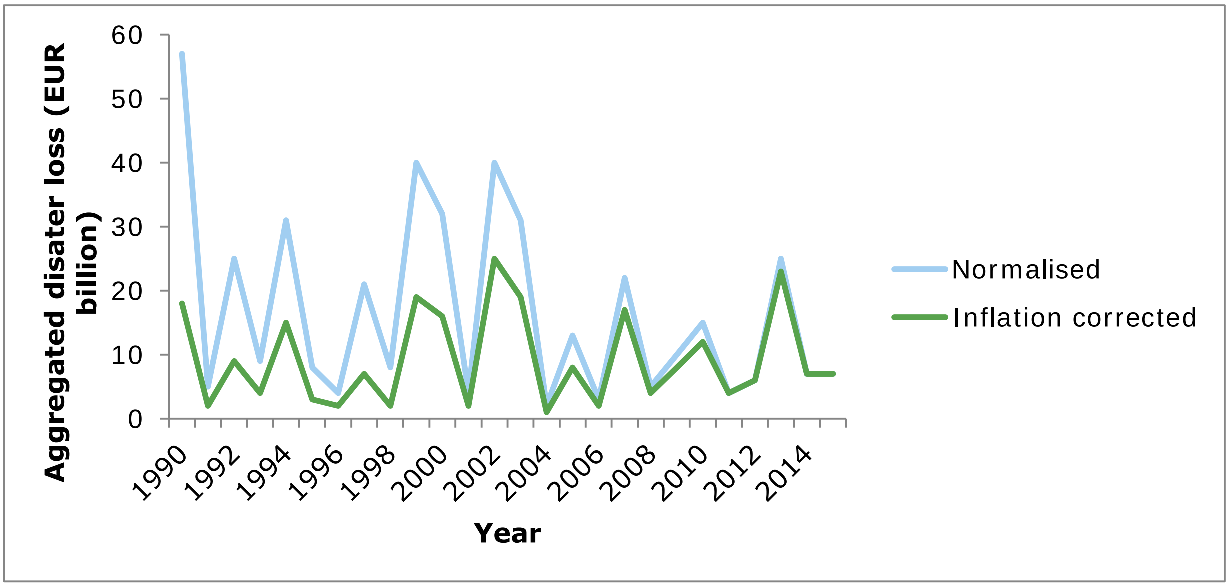



***Figure 2.3: Average normalised and inflation-corrected disaster losses aggregated across the 12 case study countries (EUR billion)***

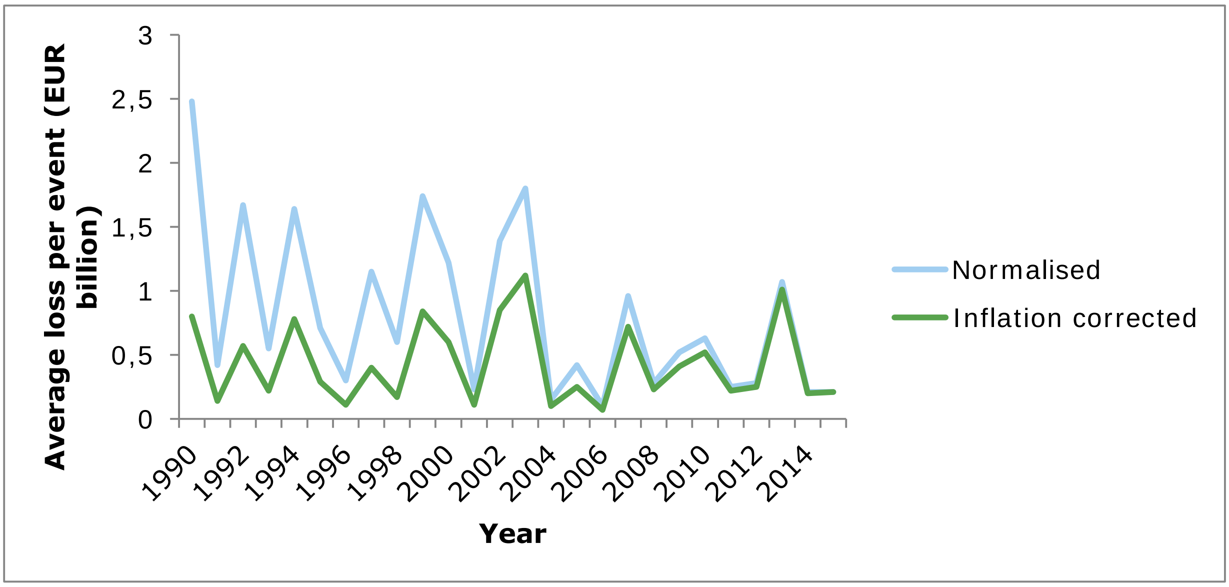



Table 2.1 presents 5-year averages of the data in Figure 2.1 to Figure 2.3. It highlights a roughly increasing number of disaster events, while the disaster impacts remain more or less constant, even with a slight increase in the number of disaster events. However, it must be noted that these observations are based on draws from the range of possible impacts. A large annual impact can be due to a series of small events or a single larger event. The values in Table 2.1 could have altered quite extensively if a sufficiently low probability event had occurred somewhere in the dataset (see the sensitivity of Figure 2.2 to the year 1990). The earlier such an extreme event would appear in the data could give the impression that impacts are falling, and the reverse inference may be made when such an event would occur later in the time period.

Moreover, the individual datasets employed reveal different directions in how losses have evolved for the 12 studied countries, highlighting the uncertainty in measuring the impacts of extreme weather events. Therefore, estimated risk may provide a more suitable metric to judge the pressure that extreme weather events may be placing on society rather than the recorded impacts which are aggregated across countries and extreme weather events. This is due to a relatively high degree of uncertainty of impacts, both in terms of what was recorded and what could have happened.

Nevertheless, we can learn from the data on observed losses that changes in exposure have played an important role in changing losses, but so have been attempts to alter the vulnerability element of the natural hazard loss function. For example, Kienzler et al. (2015) report that after a series of floods in Germany the overall level of household flood preparedness has increased over time. Moreover, there can be investment in larger scale risk management activities by local or national governments, which are hard to integrate into the above normalisation framework due to the often lack of transparency regarding how this investment money is spent.

***Table 2.1: Summary of observed disaster losses in the 12 case study countries***

| ATTRIBUTE | Period average of the number of extreme weather events | Period average of the annual loss due to disastrous extreme weather events (inflation, EUR billion) | Period average of the average annual loss due to disastrous extreme weather events (inflation adjusted, EUR billion) |
|---|---|---|---|
| **1990-1994** | 17 | 9.4 | 0.5 |
| **1995-1999** | 16 | 6.8 | 0.36 |
| **2000-2004** | 20 | 12.5 | 0.56 |
| **2005-2009** | 23 | 7.6 | 0.34 |
| **2010-2015** | 26 | 9.8 | 0.4 |
| **Period average** | 21 | 9.3 | 0.43 |

*Note: Numbers are based on the ensemble average of the recorded events across datasets in 2015 prices. The events included are those that correspond to windstorms, hail storms, fluvial flooding, pluvial flooding, coastal flooding, droughts, and heatwaves (the extreme weather events studied in this report). The final period is extended from 5 to 6 years in order to prevent 2015 from being an orphaned year.*

The data presented does not provide convincing evidence of a trend in natural disaster-related losses after accounting for socio-economic developments, which may be caused by general problems that plague NatCat datasets (see Bouwer, 2011) and normalisation procedures (Estrada et al., 2015). For example, many loss records exhibit biases and there is much less data available prior to 1980 when loss data were less reliably recorded. This data problem may have been solved by a better-structured data collection. For example, advancing communications technologies and crowdsourcing of impact information may lead to a reduction in bias and allow for the inclusion of smaller loss events that would otherwise not be included. However, additional work may be required on this topic as, for example, Thieken et al. (2016) report that (in Germany) the procedures and standards for impact data collection are widely missing. Present impact data in Germany are fragmentary, heterogeneous, incomplete and difficult to access.

In terms of observed impacts, Bouwer (2011) reviews 22 studies of normalised disaster loss trends covering a range of extreme weather events and countries. In doing so, Bouwer (2011) finds that 64 % of the studies did not discern a trend, 27 % found a positive trend and 9 % of studies found an inconclusive trend in disaster losses. Globally, studies conducted by the Global Facility for Disaster Reduction and Recovery (GFDRR) contain data (e.g. GFDRR, 2016) that imply a 6 % annual increase in worldwide losses between 1990 and 2014, assuming a constant annual growth rate. Munich Re estimates worldwide natural catastrophe losses of USD 93 bn in 2015, of which about USD 29 bn was insured. The observed trend in losses estimates a 4 % annual increase, while insured losses grew at about 6 %. Normalised disaster losses only indicated a trend when correcting for inflation.

When correcting for exposure, no trend in European losses can be found (Neumayer and Barthel, 2011). Europe, in 2015, accounted for 13 % of worldwide disaster events and monetary losses, but 45 % of the losses were insured. Winter storm and flooding in the UK caused EUR 3 bn of losses (with 66 % of insured impacts); storms in Italy and Spain caused a loss of USD 700 m. A drought in Eastern Europe caused a loss of USD 1.5 bn (Munich Re, 2016). Bartel and Neymayer (2012) investigated normalised insured losses for the years 1990 to 2008, controlling for inflation and changes in wealth. Controlling for inflation resulted in a trend, but no trends were found when controlling for inflation and changes in wealth. Bartel and Neymayer (2012) also note that there is a large variation in recorded impacts across the years. A 3 % annual growth rate in monetary impacts was found for the EU, between 1990 and 2008 (EEA, 2010). Barredo (2009) found that flood losses over the period 1970-2006 displayed an upward trend; however, once normalised the trend was not present. Barredo (2009) estimated that there was an annual normalised impact of EUR 3.8 bn across Europe, the main driver of which was socio-economic development. Barredo (2010) conducted a similar study for windstorm losses over the period 1970-2008, finding a similar result to Barredo (2009).

Kundzewicz et al. (2014) state that the economic losses caused by flood events have increased over time due to the increase in exposure of assets at risk. It has not been possible to attribute rain-generated peak streamflow trends to anthropogenic climate change over the past several decades. The climate signal (i.e. climate change effects on changing patterns of precipitation) is less spatially coherent and less statistically significant compared to observed changes in temperature extremes. However, several studies of a range of regions did not show a signal related to anthropogenic climate change in flood losses (Pielke and Downton, 2000; Downton et al., 2005; Barredo, 2009; Hilker et al. 2009; Neumayer and Barthel, 2011; Barredo et al. 2012). A few other studies observed a partial relationship between recent increases in flood losses and (short-term) changes in intense rainfall events (Fengqing et al., 2005; Chang et al., 2009; Barthel and Neumayer, 2012), and some studies find an increase in damages related to flash floods and a changing incidence in extreme precipitation (Changnon, 2001). However, a Swiss study of normalised losses from flash floods and landslides failed to identify any significant trends (Hilker et al., 2009).

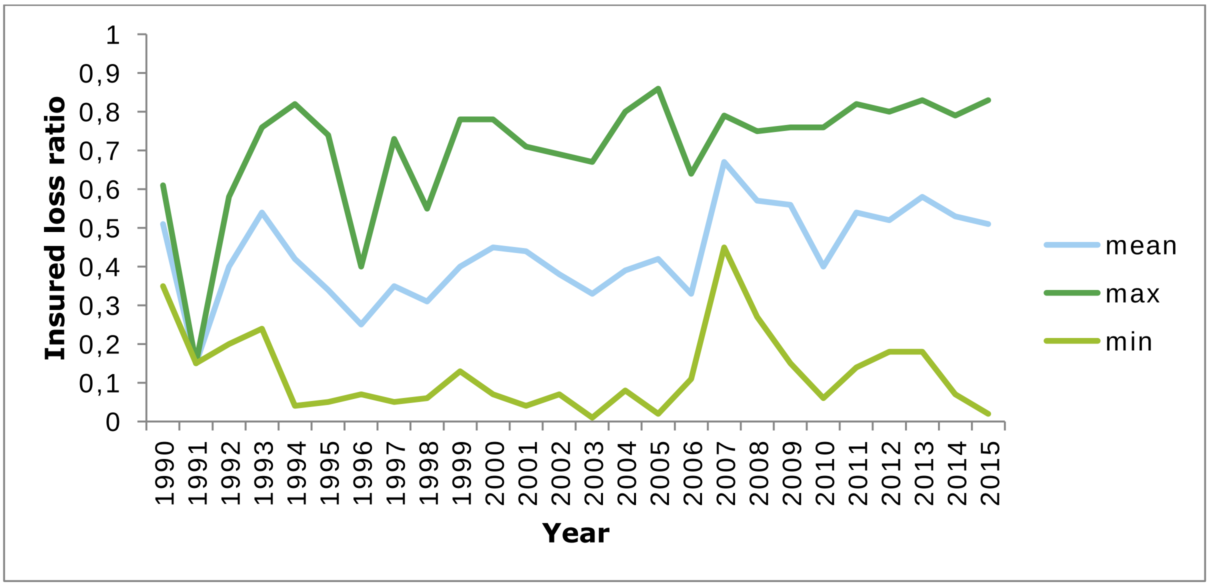
### *2.1.2 Comparison of insured and non-insured losses*

The ratio of insured to total monetary losses is an often-used metric for measuring the insurance 'coverage gap' (e.g. Munich Re, 2016; Swiss Re, 2016). However, this metric should be treated with caution as it includes impacts from people who cannot be insured (i.e. for whom insurance is not available), people who voluntarily choose not to be insured, the potential limits on the total amount of compensation that can be offered or the deductibles that policyholders choose. Therefore, a ratio of 1 is not always an optimal target since some elements of risk should be shared across the various participants in the insurance market.

The two datasets provided by reinsurers[4] have data points that associate an insured loss with the total damage suffered for a given disaster event. Therefore, the ratio of insured loss to total economic loss per disaster event can be produced. Figure 2.4 presents this ratio per year as one of the following three outcomes. The main indicator is the mean ratio per disaster event that occurred across the EU Member States for a given year.

In addition the minimum ratio per disaster event observed for a given year as well as the maximum observed ratio are shown in the figure[5]. The three indicators are produced as the average of that contained in the two reinsurance datasets. However, it must be noted that data points on insured losses were rarer than observed losses. For example, 1991 only has one observation of insured losses contained in the Munich Re dataset meeting the requirements of this report. Moreover, the data is biased towards countries with more developed insurance markets (e.g. Germany, France, Spain, and the UK).

***Figure 2.4: The ensemble ratio of insured natural disaster damage to economic damage***




*Notes: 'mean' represents the average ratio across extreme weather events studied; 'max' represents the highest ratio across extreme weather events; 'min' represents the smallest ratio across extreme weather events.*

The data presented in Figure 2.4 show that during the period 1990-2015 there was an average ratio of 0.43 for the mean ratio value, with an average annual maximum value of 0.71 and 0.13 for the average annual minimum. The mean value appears to be relatively constant across the period, although it slightly increases over the period (an annual rate of 0.008 points). The range also slightly increases over the period studied at a trend rate of 0.008 points per year. However, some of this increase must be attributed to the wider coverage in terms of countries studied after the year 2000.

Table 2.2 presents the average ratio (across all EU Member States during the period 1990-2015) for the different disastrous extreme weather events that could be isolated. The Sigma dataset identifies events by their primary extreme weather event. The NatCatService dataset provided the main disastrous extreme weather events involved, but did not clearly state which was the prime event.

[4] The datasets are obtained through institutional agreements and subject to confidential use of the individual datasets.

[5] However, it must be noted that the events with both a total and an insured loss reported may tend to be larger events. However, these events may be where the benefits of insurance are most strongly felt as, proportionally, less of the loss is retained by the household or other affected agent.

*Table 2.2: Average ratio of insured damage to economic damage per event, 1990-2015*

| Extreme weather event | Average ratio | | Average ratio |
|---|---|---|---|
| **Sigma** | | **NatCatService** | |
| Drought (heatwave) | 0.33 | Drought (heatwave) | 0.34 |
| Floods (various) | 0.43 | Flood | 0.35 |
| Hail | 0.53 | Flood and storms | 0.49 |
| Storms | 0.61 | Storm | 0.8 |

Both datasets provide a roughly similar ratio for droughts which stands at about one-third of the damage suffered, mainly because of the very high ratio in France (over 0.8). Floods were the most common disastrous extreme weather event, while storms had the highest ratio of insurance coverage.

The damage associated with storms is often masked by the simultaneous occurrence of floods (resulting in difficulty in attributing losses to specific extreme weather types). The high ratio for storms is observed because of the general coverage of such events in general property insurance contracts with low deductibles. However, when the damage is also occurring together with floods, then less of the total damage will be covered.

### 2.1.3 Initial conclusions regarding past losses

This chapter provides an overview of natural disaster losses between 1990 and 2015 for total monetary losses and insurance claims. The inter-annual volatility in the size of events and their corresponding losses makes it difficult to spot long-term trends in losses over the 12 case study countries. This is due to the fact that it is hard to distinguish what is a trend vs. random chance related to natural variability. However, the ratio of insured to total losses appeared to increase slightly over time, around an average of 0.5 over the entire period. The same ratio, but specified for the different hazard types, shows that hail and windstorms have the largest ratio, which implies that most of these losses are insured. For floods and droughts, the ratio is significantly smaller. This difference is likely to be caused by the fact that hail and windstorms are less geographically bound to location-specific conditions and thus are able to occur almost everywhere, while droughts and floods are more localised and systemic, affecting large numbers of policyholders at the same time. This finding also suggests that insurers face challenges with insuring localised and potentially systemic disastrous extreme weather events because for such events the conditions for a viable insurance product may not hold (see Chapter 4 for more details on what these conditions are).

There was (slightly) stronger evidence presented for an increasing trend in the number of disastrous extreme weather events occurring over time.[6] This finding highlights a potential problematic area for the future insurance of (disastrous) extreme weather events. Models that estimate insurance premiums commonly use three variables (e.g. Hudson et al., 2016): the potential loss, the probability of loss, and a loading factor to cover the costs of doing business and to make a profit. The increasing number of events (even if it is difficult to establish a

[6] Caution must be taken in interpreting this finding from a study of loss events rather than the raw hazard data.

corresponding increase in losses) could act as an indicator of an increasing probability of a loss which can either result in (1) increasing insurance premiums, or that (2) policyholders will more often find themselves caught in their insurance policy's deductibles, which could make them question the value of insurance products.

Risk reduction can play an important role in minimising problems with the affordability of insurance or solvency concerns. By implementing adaptation or mitigation measures, the impacts of extreme weather events would be significantly reduced, relieving pressure on both policyholders and insurers.

## *2.2 Projected losses for between 2030 and 2050*

Projection of future losses is difficult because the observed loss data has high annual fluctuations and has been mainly driven by socio-economic factors which are not constant. In addition, loss estimation in itself is highly uncertain (Bouwer, 2013). As explained above, the three drivers of risk (exposure, vulnerability and hazard) are not constant trends. For example, changes in vulnerability (e.g. improved rates of disaster risk reduction or DRR) and exposure (e.g. higher asset values or population numbers) are highly uncertain and unpredictable trends. Large variations on impacts can occur because vulnerability and exposure are highly variable and spatially differentiated. Jongman et al. (2015) note that observed and predicted past impact estimates have deviated due to the fact that risk models often cannot account for human behaviour when projecting future impacts. Therefore it is difficult to produce authoritative projections of future impacts as drawn from risk models or observed trends due to the broad range of uncertain drivers (Bouwer, 2011). Moreover, insured losses also suffer from changes in insurance penetration rates, or changes in policy conditions like deductibles. This can result in highly uncertain changes in impacts.

Current risk models that aim to predict future natural disaster risk often focus on changes in exposure and on direct monetary losses (Bouwer, 2013). However, there is disagreement on how future impacts should be modelled and what factors should be directly included in the models (Bouwer, 2013). For example, indirect or intangible impacts are more difficult to estimate in monetary terms, although efforts are made to adopt these impacts in mainstream modelling frameworks (e.g. Koks et al., 2016; Hudson et al., 2017a). Often studies project values for risk rather than focusing on specific events (Bouwer, 2013). Even though there are scenario approaches that can be used to project extreme weather losses with a combination of climate, socio-economic and vulnerability scenarios, it should be noted that they are rare (Bouwer, 2013). Vulnerability is another important driver (Bouwer, 2013; Jongman et al., 2015). However, changes in vulnerability are often modelled as exogenous changes that occur at a single moment (e.g. Jongman et al., 2014) rather than as adaptive behaviour that occurs when risk develops. An exception is Haer et al. (2017), who present an example of such a study for fluvial flood risk. The model results presented in the following sub-sections assume a fixed level of adaptation or changes in vulnerability that correspond to a policy change.

Due to the nature of studies that investigate the potential of increasing losses from extreme weather events, it is difficult to present the outcomes in turn across the case studies. Precise and comparable values for these projections are not consistently available. This is due to the different modelling frameworks employed as well as different assumptions on how climate change and socio-economic drivers of risk will develop. However, it is expected that risk related to natural hazards will increase over time (EEA, 2017; IPCC, 2012). The next sections will give estimates of the total monetary losses for some of the case studies, followed by some estimates per disaster type, on a European scale.

*Specific country estimates*

Localised projections were available for the following four countries while, subsequently, we present an overview of EU-wide studies.

*Austria*

Prettenthaler et al. (2015) study future fluvial flood risk for Austria. They estimate that between 2016 and 2045 the annual average loss from fluvial flooding is EUR 288 million to EUR 940 m, which was estimated to grow to between EUR 430 m and EUR 1.8 bn for the period 2036-2045.

*Germany*

Leckebush et al. (2007) estimate that by mid-century winter storm losses could increase by 40 %. This result is similar to a study of summer storms by the German Insurance Association (GDV), which predicts an average increase in windstorm losses by 25 % over the period 2011-2040 as compared to the period 1984-2008. While comparing the average claim in the period 1984-2008 with the projected outcome in the period 2041-2070, it could be 61 % higher. However, this masks a large amount of spatial variation across regions of Germany. In addition, the GDV estimates that a 15 % increase in claim rates for general homeowners insured during the period 2011-2040 compared to the period 1984-2008; between 2041 and 2070 it could be 47 % higher under the SRES A1B scenario7 of climate change (Munich Re, 2016). Te Linde et al. (2011) estimate that the flood risk associated with the Rhine river risk could double by the end of the century. Huang et al. (2015) estimated an increase in droughts for the Rhine in Germany. This may seem conflicting but floods and droughts could occur at different times, indicating potentially growing seasonal variation. Moreover, there is the potential for more flash floods when drainage conditions are subjected to more extreme rainfall conditions.

*United Kingdom*

Fluvial and coastal risks make roughly equal contributions to future risk, while surface water flooding contributes less (Sayers et al., 2015). Based on current adaptation trends, when assuming no population growth, residential risks could grow by 6 % by the 2020s and by 26 % by the 2050s with a 2 °C increase in temperatures. A 4°C increase in temperature could result in residential risk increases of 35 % or 82 %, respectively. Positive population growth can result in larger increases in risk. For the agriculture sector, a 2 °C temperature increase could result in a 1 % increase in the land exposed to flooding (with a flood probability higher than 1/75) growing to 15 % by the 2050s. A 4 °C temperature increase would increase the land exposed to flooding by 19 % and 39 %, respectively. Turning to non-residential (commercial) properties at risk of flooding, the 2 °C scenario can increase the number of non-residential properties exposed to flooding by 3 % and 16 % respectively. With a 4 °C increase, the values are increased to 18 % or 42 %. Among the regional studies of the UK is a scenario analysis of damage due to river and coastal flooding in England and Wales in the 2080s (Hall et al., 2005). This study combines four emissions scenarios with four scenarios of socio-economic change in a Special Report on Emission Scenarios- (SRES) like framework. In all scenarios, flood damages are predicted to increase unless current flood management policies, practices and infrastructure are improved. For a 2 °C temperature increase in a SRES B1-type world[8], by the 2080s annual damage is estimated to be GBP 5 bn as compared to GBP 1 bn today, while with approximately

[7] The A1B scenario describes very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies (with a balanced development of fossil fuel and non-fossil fuel technology).

[8] The SRES B1 scenario describes a world with growing and then falling population, combined with a rapid change towards a service and information-based economy with a higher focus on clean and efficient technologies.

the same climate change, damage is only GBP 1.5 bn in a B2-type world. In an A1-type world, with a temperature increase of 2 °C, the annual damage would amount to GBP 15 bn by the 2050s and GBP 21 bn by the 2080s (Hall et al., 2005; Evans et al.2004).

The impacts on agriculture insurance can be estimated by analysing how agricultural yields change. If crops are insured on a yield basis, then potentially higher yields can result in higher premiums or indemnity payments. By combining national datasets on historical wheat yields with climate data, a simple yield response to the temperature metric was developed and used to estimate future yield changes in Knox et al. (2012). From this, potential increases of wheat yields were projected to be a central estimate of 47 % (range 22 % to 76 %) by the 2020s for the A1B emissions scenario, which increases to a central estimate of 79 % (range 36 % to 137 %) by the 2050s for one emissions scenario and a central estimate of 111 % (range 46 % to 212 %) by the 2080s for the A1B emissions scenario. However, it is important to note that these projections relate to changes from a 1961 to 1990 baseline. A more recent study by Thomas et al. (2011) using the probabilistic UKCP09 projections suggested mean wheat yield increases of 11.5 %, which is broadly similar to those reported by Semonov (2009). The assessment also considered the climate impacts on sugar beet, projecting an increase in sugar beet yield of 23 % by the 2020s for the medium emissions scenario, rising to 39 % by the 2050s, and to a central estimate of 55 % (range 23 % to 105 %) by the 2080s for the medium emissions scenario (all from a 1961-1990 baseline).

*France*

A study for France indicates that the losses from extreme weather events will increase (river flooding, coastal flooding and droughts). Based on the Representative Concentration Pathways (RCP) 4.5 climate change scenario and an associated change in exposure scenario (assuming a constant vulnerability), the monetary losses from extreme weather events are projected to double in France by 2050 as compared to 2015 (approximately EUR 2 bn). The main drivers of this increase in losses are changes in exposure (accounting for 80 %), while climate change provides the remainder. For example, the annual costs charged to the Cat Nat insurance system could increase by an average of around 114 % in metropolitan France by 2050, of which climate change only contributes a 3.1 % increase in mean annual losses within metropolitan France as a whole (CCR, 2015).

*EU-wide studies*

Forzieri et al. (2016) discuss the projected damages for the EU's critical infrastructure due to climate change-related disasters and estimate that damages could triple by the 2020s and increase six-fold by 2050. Currently, river floods (44 %) and windstorms (27 %) are the hazard with the highest contribution to damages caused by climate change-related hazards. However, it is estimated that droughts and heatwaves are likely to become the most damaging hazards (Forzieri et al., 2016). This section discusses projected losses due to climate change for each of the four climate change-induced hazards.

*Windstorms*

The risk of storms, especially severe winter storms and possibly severe autumn storms, are projected to increase in many parts of Europe, especially in North Atlantic and northern, north-western and central Europe (EEA, 2017). Bouwer (2013) reports that based on several studies, the losses from windstorms could increase by 11 % to 120 % by 2040, depending on the country, with a median impact of 15 %. For this, exposure and vulnerability changes are more important than climate change (Bouwer, 2013). One study estimates that the current EU-wide average annual loss for winter storms is EUR 2.6 bn, growing to around EUR 11 m a year until 2085 with an expected loss of EUR 3.5 bn, which is a growth rate of 44 % (Schwierz et al., 2010). However, a separate study indicates that the risk from storms may have instead increased at a rate of USD 120 m a year (Mohleki and Pielke, 2014). A further study indicates that the northern parts of Europe are projected to have more rain and increased storm intensity (Dorland et al., 1999; Vousdoukas et al., 2016). In particular, a 2 % increase in storm intensity is predicted to increase associated losses by 80 %, and a 6 % increase in storm intensity could lead to a 500 % increase in losses (Dorland et al., 1999). It should be noted that there is a wide range of uncertainty in these estimates.

*Flooding*

For the Joint Research Centre's (JRC) PESETA II report, Ciscar et al. (2014) used the LISFLOOD model by Rojas et al., (2013) to estimate changes in both frequency and severity of river flooding. Current estimates suggest that direct economic damages caused by floods in the EU are around EUR 5 bn/year, which, driven by climate change, are projected to more than double by 2080 under the EU Reference Scenario (Ciscar et al., 2014). These damages are mostly incurred by the UK and Ireland, where damages triple up to EUR 3.3 bn/year, and the Central Europe South region where damages increase from EUR 2 bn to EUR 5.2 bn/year (Ciscar et al., 2014). The JRC PESETA II report estimates that the number of people in the EU affected by floods on an annual basis is projected to increase from 160 000 to 240 000 people/year by the end of this century under the EU Reference Scenario (Ciscar et al., 2014). A 2 metre sea-level rise would exacerbate losses by 67 % for coastal flooding and increase the number of people affected by 40 % (Mokrech et al., 2015). The combination of an increase in precipitation and sea-level rise make it very likely that costal floods or storm surges will mostly affect regions connected to the North Sea, but there is a large degree of spatial variation in impacts (Paprotny et al., 2016).

Hinkel et al. (2010) investigate the combined impacts of coastal and river flooding under two climate and socio-economic development scenarios, with and without climate change adaptation. Without adaptation under the SRES A2 scenario, the combined risk is estimated to increase from EUR 3.2 bn in 2010 to EUR 4.8 bn in 2030 and EUR 6.4 bn in 2050. Assuming the presence of climate change adaptation, risk grows from EUR 1.8 bn in 2010 to EUR 2 bn by 2050. Similarly, under the SRES B1 scenario, risk is projected to increase from about EUR 3.3 bn in 2010 to EUR 8.1 bn in 2050, and with adaptation risk decreases from EUR 1.9 bn in 2010 to EUR 1.5 bn in 2050. A different study indicates that flood risk across Europe could be increasing at a rate of EUR 250 m per year (Mohleki and Pielke, 2014).

*Droughts and heatwaves*

The JRC PESETA II report (Ciscar et al., 2014) presents an extensive study on the impacts of climate change on agriculture in Europe. Simulations based on the 'warm' climate scenario suggest that yields in southern Europe are expected to increase as they are caused by changing rainfall patterns. However, due to the impacts of droughts, EU cropland affected by this particular peril is expected to increase substantially under the A1B climate scenario, especially in southern Europe, followed by southern central Europe (Ciscar et al., 2014).

Crops growing in the Iberian Peninsula may be subjected to damagingly high temperatures during the sensitive development periods of flowering and grain filling. The stress placed on crops will grow most strongly for summer rather than winter crops (Ruiz-Ramos et al., 2011). Therefore it is likely that agricultural impacts from droughts and heat stress will increase; however, this potential for increased heat stress is not confined to the Mediterranean area.

Across the EU, the IPCC (2012) reports that there is medium confidence that droughts will get worse in southern Europe, the Mediterranean area and central Europe, while there is low confidence in this prediction for the rest of Europe. The IPCC (2012) assigns a high confidence to the assertion that the value of losses has increased. Beniston et al. (2007) study the potential increase in heatwaves across Europe. They find that in central Europe there will be more hot days, while in the countries surrounding the Mediterranean Sea, droughts will occur earlier in the year and will last longer. Again, these projections are highly influenced by the applied scenario. Furthermore, droughts are projected such that 20 % of the European land mass may experience significant increases in moderate and severe drought months between 2011 and 2040 (Stagge et al., 2015).

However, due to climate variability, the total area with significant increases in drought frequency is projected to expand throughout the century, with an increase in 35-65 % of the total area subject to moderate drought frequency and an increase in 10-30 % in the area subject to severe drought frequency (Stagge et al., 2015). Model agreement is strongest for moderate droughts; the duration of drought events is not projected to change significantly in the next 30 years, but may be significantly different for 10-30 % of the European land mass by the period 2070-2100 under the RCP 8.5 scenario (Stagge et al., 2015). Similar to the proportion of drought months, the areas with significant changes in drought duration are predominantly located in the Mediterranean and Atlantic coastal regions. Droughts are projected to increase throughout the Mediterranean, including the eastern Mediterranean and North Africa, and the Atlantic coastal region, including France, the UK and the Rhine river valley. These increases are due to a general shift towards a drier climate in the Mediterranean and an increase in precipitation variability along the Atlantic coast. This results in an overall increase in both moderate and severe drought frequency for the entire region, with significant increases in the number of drought events, and an increase in maximum drought duration for the Mediterranean region (Stagge et al., 2015).

### *2.2.1 Initial conclusions regarding future losses*

The objective behind this section is to provide an overview of the expected losses over the period 2030-2050 for both total monetary loss and insurance claims over the same period, where these forecasts were available.

Providing a consistent approach to forecasting future losses was not available due to the varied combinations of modelling approaches and differing potential scenarios regarding climate change or exposure to growth. This creates a great deal of uncertainty in the way that future losses will evolve and how insurers or governments may have to respond to this. However, this is not necessarily a problem in itself. The broad range of modelling approaches and potential scenarios used can help prevent a new systemic risk from developing whereby all the stakeholders are using the exact same approach with the same benefits and flaws. The range of approaches can create a more holistic view of the problem, adding value to data sources that different actors may not have considered.

The results are fairly consistent, however, in that they forecast an increase in extreme weather risk on the whole (which may or may not materialise within a given year, due to natural variability). This in turn highlights the role that risk reduction can play in maintaining the viability of extreme weather insurance because an increase in the number of extreme weather events can pose challenges for insurance.

## *2.3 Loss drivers of current and future impacts*

Given the uncertainty in climate impacts and natural variability in natural hazards, it is impossible to attribute individual extreme weather events to anthropogenic climate change (IPCC, 2012). Changes in exposure, however, may be more easily observed, and are deemed to be the main drivers of changing impacts with a high degree of confidence (IPCC, 2012). Uncertainty makes it difficult to formulate a meaningful message that could be conveyed to practitioners and decision-makers interested in implementing natural disaster risk management strategies in a particular locality, yet they seem useful to provide. However, despite this difficulty, a portion of changing risk or impacts is related to changes in weather patterns. Nonetheless, there are indications that population and assets exposed to natural disasters have increased more rapidly than overall population or economic growth (Bouwer et al., 2007; Di Baldassare et al., 2010; Bouwer, 2011; Jongman et al., 2012), even if there may have been an overall reduction in their vulnerability (Jongman et al., 2015).

### *2.3.1 Changes in exposure*

Exposure was found to be the main driver of natural disaster impacts in many studies (Bouwer, 2011). Over the past 50 years exposure changes have been the main driver for natural disaster losses (Bouwer, 2013). For example, socio-economic growth in flood-prone areas is a major driver of various extreme weather risks (IPCC, 2012). As a result, there were more properties exposed to extreme weather events and also more people reported impacts. A higher exposure to these extreme events will result in more reported loss events and larger potential damage (Stevens et al., 2013). An increase in exposure can result from rational individual decisions, for example because economic productivity is higher in areas at risk of natural hazards. Alternatively, individuals may underestimate natural disaster risk. If in that case an increase in disaster losses were to be included in decision-making processes, investments may shift towards adaptation or a reallocation of assets to lower risk areas. For disaster losses to be included in the decision processes, risk has to be approached rationally, which is often not the case due to myopic expectations (the actor only focuses on a short time horizon, which is inappropriate for managing extreme weather events), a lack of information, moral hazard and externalities. Estimates of exposure in the far future (e.g. after 2030) are likely to be unreliable due to these behaviour irrationalities and the general difficulty in projecting complex human behaviour.

*Flooding*

Kundzewicz et al. (2014) state that the economic losses from floods have been generally increasing, principally driven by the expanding exposure of assets at risk. Llasat et al. (2014) argue that changes in population density and land use are the most probable cause of the observed trend. Elmer et al. (2012) find that the main driver of risk in parts of Germany is the growing amount of urban areas. Uncontrolled or unprotected urban development will be a strong driver for future losses (Bouwer, 2013). Due to the local nature of pluvial flood risk, unplanned urban development could lead to a very sharp increase in pluvial flood risks. Visser et al. (2014) argue that changes due to human behaviour are the largest driver of losses. Winsemius et al. (2016) present projections for flood risk across Europe, finding that across most of Europe exposure is the most important driver as compared to climate change, while in other regions it is a roughly equal driver.

*Droughts*

According to the EC's Water Scarcity and Droughts Impact Assessment (2007), the number of people and areas affected by droughts has gone up by almost 20 % from 1976 to 2006. The 2003 drought, which was amongst the most widespread one at the time of writing, affected over 100 million people and damage to the European economy was estimated to be at least EUR 8.7 bn. The IPCC's 5$^{th}$ assessment (2014) acknowledges the difficulty in assessing future trends for drought risk in the EU. Nonetheless, it is expected that southern Europe will experience longer meteorological dry spells (IPCC, 2014). Droughts are the second climate risk where exposure (demand) changes can be important. The effects of increasing water usage results in approximately the same impact as climate change. The impact of increasing demand for water on the occurrence or intensity of droughts is predicted to be particularly strong in eastern Europe. There could be a large degree of regional variation as intensive water consumption could aggravate drought conditions by 10 to 30 % (by the end of the century) in southern, western and central Europe, and to a lesser extent also in the United Kingdom. Moreover, some regions may be subject to small impacts of climate change, which are turned negative due to intensive water use. This is the case for north-western Germany, north-western France and parts of the United Kingdom, as well as parts of Hungary and Romania.

### 2.3.2 Changes in vulnerability

Countries often have a significant regional variation in protection standards, similar to the large differences between countries (Bouwer, 2013). For instance, Scussolini et al. (2016) estimate that Bulgaria has an average protection standard against floods with a 20-year return period, while Poland has protection standards averaging a 200-year return period. Most risk models do not account for this variability in vulnerability between countries. Birkmann et al. (2010) argue that after disaster events there are windows of opportunity that reinforce the ability to reduce vulnerability. Jongman et al. (2015) note that globally there has been a general reduction in vulnerability given that observed impacts have deviated from predicted impacts.

The vulnerability driver is important and can have noticeable impacts on extreme weather losses. However, including adaptive behaviour in risk models is difficult because of individual specific experiences and beliefs or political processes. There is currently insufficient information at the varying scales required to provide reliable information on how losses may change due to vulnerability changes. Bubeck et al. (2012) study the role of vulnerability on impacts from the floods in 1993 and 1995 in the German part of the River Rhine. They note that the hydrological flood events that occurred were very similar, but the damage suffered by households located in this area was smaller in 1995 than in 1993 due to the greater use of household-level risk reduction measures. A second Germany-based study finds that after a series of floods in 2002, 2005 and 2011, the average level of flood preparedness tended to increase as well as the continuing development of early warning systems by the Government (Kienzler et al., 2015).

However, quantifying such reductions in vulnerability is difficult due to incomplete record keeping of protection standards (e.g. policy rules vs. actual practice) or household-level risk reduction measures, their overall effectiveness and how the employment rates of these measures vary over time. The results shown in Table 2.1 and Figure 2.3 indicate, loosely, that vulnerability may have declined because losses remained constant, even with a slight increase in the number of recorded extreme natural disaster events. However, no firm conclusion about this can be drawn due to the relatively short time period and high annual variability of disaster losses.

### 2.3.3 Changes in natural hazard(s)

The change in the hazard element is primarily influenced by natural variability or climate change, but may significantly vary regionally. Most studies conclude that the predicted changes in hazard characteristics are not the main driver of increased risk, although in places it may be a roughly equal driver to changes in exposure for specific risks. Caisse Centrale de Reassurance (CCR) (2015) highlights that climate change (on the whole, across weather risks) is projected to only contribute about 20 % of the increasing risk in France, while exposure contributes the remaining 80 %. Moreover, due to the temporal, spatial and inter-annual variability it is easy to view a trend in disaster losses as a sign of anthropogenic climate change, while in reality the trend is due to other causes (Bouwer, 2011). However, as shown in the previous sections, this may hold for the economic impacts but not necessarily for the number of events themselves.

*Flooding*

Several studies examined trends in flood hazards. For example, Stevens et al. (2013) use 125 years of recorded flood events in the UK to establish an increasing trend in the number of floods reported. However, a consistent trend in the number of floods per capita during the 20th century is not observed when the reported number of flood events is normalised for exposure using population and number of dwelling houses in the UK (Stevens et al., 2013). Increasing trends in heavy rains have been documented in some regions (Trenberth et al., 2007), but an ubiquitous increase in flood maxima is not evident (e.g. Kundzewicz et al., 2005). For example, an analysis of the time evolution for the Barcelona rainfall series (1854-2000) shows that no trend exists in terms of cloudburst, although impacts have altered over this time due to changes in urban planning (Barrera et al., 2006). Llasat et al. (2014) study the evolution of floods in Catalonia, and find an increase of one flood per decade due to extraordinary events that did not display a trend in themselves. Hirsch and Archfield (2015) also use precipitation data to show significant increases in the frequency and magnitude of heavy precipitation events in many areas, but cannot conclusively show that the size of floods is increasing. Although this trend is not systematically observed, it may be related to heat waves and droughts (Bouwer, 2011). Rouider et al. (2015) note that it is difficult to draw firm conclusions about trends in future flood losses due to the high degree of spatial variability. Nevertheless, Rouider et al. (2015) state that the hydrological cycle is going to become more intense across Europe due to climate change, leading to a general increase of flooding across the continent.

*Storms*

Feser et al. (2014) provide a comprehensive review of studies of long-term storminess from observations, which include long-term records of wind speed, mean sea-level pressure and sea-level height. Analyses of long-term wind records in the UK and Ireland (Hammond, 1990; Sweeney, 2000; Hickey, 2003; Ciavola et al., 2011) have found large decadal variations in storminess, but no significant long-term trends. In contrast, Esteves et al. (2011) found a significant decrease in storminess over the period 1929-2002 at Bidston Observatory (Wade et al., 2015). Consequently, to-date observations provide no conclusive evidence on how climate change affects storms.

For France, it has been observed that the spatial variability of trends in hail records from individual stations was extremely high. Even over small areas, there are opposing trends between nearby observation stations. Moreover, a potential link is made to varying trends across months of the year (Hermida et al., 2013). An analysis of hail damages and temperature series for peninsular Spain (Requejo et al., 2011) does not confirm the results previously obtained for France and the Netherlands, which relate hail damage to the average minimum temperature (Botzen et al., 2010). This is a complex problem since the available time series data of hail damage is non-homogeneous and non-continuous. Therefore, designing a consistent model across geographical regions is very difficult (Piani, 2005; Fraile et al., 2003). The local conditions of hailstorm formation are very important to account for in a hailstorm risk assessment, which implies that determining hail impacts with larger scale models commonly used in risk management is problematic. In terms of insured losses for the Spanish agriculture sector between 1981 and 2007, the production of 79 % of winter cereals, 78 % of fruits, 39 % of vineyards and 14 % of olive trees, all susceptible to hailstorm damage, were covered by insurance (Requejo et al., 2011). Requejo et al. (2011) find similar results to those that were discussed for France above with regard to the very large degree of spatial variation in trends in hail records.

*Droughts*

Lehner and Doll (2001) indicate that climate change projections generally imply a change in drought frequencies across Europe. Northern and small parts of central Europe (e.g. Germany) show a decreasing trend in future drought frequencies by the end of the century. The regions most affected by increased drought risk from climate change are southern Europe. For example, Spain, western France and parts of eastern-central Europe (e.g. Poland) may experience a drought with a 1 % annual probability that would become the equivalent of a drought with a 10 % annual occurrence probability. Also, for areas of the UK, Italy and in eastern-central Europe, drought risks are expected to increase as a result of climate change. For example, Forzieri et al. (2014) report that areas that consume water from rivers, may find that the minimum river flows may fall by 40 % due to climate change in areas of Spain, France and Italy, increasing the likelihood of a significant drought or water-scarce events (EEA, 2017). Rouider et al. (2015) point out that expected trends in drought may not be very robust. The individual climate model used can have important impacts on the specific drought prediction since the model can be very spatially and temporally specific. Similar uncertainty results from the precise set of climate scenarios used. Moreover, a large source of uncertainty arises from the hydrological modelling process.

### 2.3.4 Initial conclusions regarding the drivers of risk and losses

This section breaks down risk into three main drivers: exposure, vulnerability and hazard. Out of the three, exposure is recognised as the main driver of increases in predicted losses by natural hazards. Socio-economic development in hazard-prone areas is likely to continue in the coming decades and, furthermore, will put more people and assets at risk.

The role of climate change and its role in potential changes in hazards have proven difficult to account for in determining projected losses. This is due to the extreme volatility of losses and that a past record of accurate climate change measures are lacking, making it difficult to extend trends and projecting future changes. Still, climate change is expected to influence changes in hazards, even though associated impacts are uncertain.

Vulnerability is an important driver although there are no clear projections for the near future. However, risk reduction via mitigation or prevention can be important in maintaining the insurability of extreme weather events.

The two indicators that we have identified as being the more important, immediate, drivers of losses (based on current trends) are exposure and vulnerability. Compared to the climate change element, these two elements are more directly under the control of the various national stakeholders. Therefore, there is a role for an increasing focus on disaster risk reduction or adaptation. A strong focus on these topics can limit the extent to which changes in exposure and vulnerability lead to an overall threat from extreme weather events.

## 2.4 Chapter conclusions

An examination of a combination of available loss datasets for the selected European cases shows it is not yet very clear whether there is an increase in monetary impacts from extreme weather events. The key loss drivers are increases in wealth in general, and increased exposure of assets and infrastructure in hazard-prone areas (EEA, 2017). The effect of climate change is, by comparison, more difficult to determine due to natural variability of natural hazards and often-unobserved changes in vulnerability, especially when the data used is primarily focused on monetary values. Under most climate change scenarios, the intensity and frequency of extreme weather events will increase in the future. This implies that probably the damage costs will also increase, unless more proactive disaster risk management measures are taken. This is a key argument for an interest by policymakers and other actors within countries and the Commission in adaptation policies and actions, including insurance mechanisms (EEA, 2017; Kurnik 2017).

The risk profile across the case studies and by extension across the European Union is changing towards a situation where extreme weather events are becoming more common, with an overall increase in risk. This will place an increasing burden on the budgets of policyholders, insurers and governments to absorb these impacts.

During the period 1990-2015 it appears that there has been a slight increase in the total percentage of damages due to an extreme weather event that was covered by insurance payouts, although this finding should be treated with caution due to data limitations. While this ratio is unlikely to reach 100 % due to risk being retained by policyholders (by not insuring or through deductibles), higher values do indicate an increase in risk transferred to insurers.

One missing element of the conducted risk assessments, or in studying the past development of extreme weather events, is the integration of changes of vulnerability into the assessment frameworks. The authors observed that very few studies of future extreme weather risk include the behavioural elements of adapting to extreme weather risks as an integrated component of the modelling framework. Instead the studies made simplistic assumptions about adaptation to changing natural hazards, for example through assuming fixed or overall increases in large-scale prevention measures.

Given the potentially large impacts of individual extreme weather events (sections 2.1 and 2.2), it is imperative to design adequate risk reduction strategies to limit future losses. The active engagement of all stakeholders to better understand risk and risk-reduction measures and to act to reduce threats posed by extreme weather events can create a more disaster-resilient society.

# 3. PRESENTATION OF CASE STUDIES AND OVERVIEW OF THEIR APPROACHES TO INSURE EXTREME WEATHER RISK

Insurance or insurance-like mechanisms can make society more resilient to the impacts that emanate from extreme weather events in a variety of ways. The first way is that insurance mechanisms can provide financial compensation for large disaster losses so that those affected can recover quicker. The quicker the recovery the smaller the impacts of a disaster are likely to be in the long run, which helps to make society more resilient. Moreover, underwriting and the design of insurance schemes requires a good understanding of the threats that are insured against. Therefore insurance companies can play a large role in assessing and signalling risk so that those at risk can have a better understanding of the threat posed. Moreover, those stakeholders involved in the insurance sector can generate a framework in which they provide incentives or requirements for risk management, which in turn can limit the potential impacts of an extreme weather event. While argued to be currently weak across Europe (Surminski et al., 2015), this link between insurance and risk reduction can be strengthened. Strengthening this risk reduction role through increased prevention and adaptation can reduce the pressure that extreme weather events place on society, which enhances disaster resilience (Botzen, 2013).

The purpose of this chapter is to highlight the selected case studies, and to expand upon the justification for their selection in terms of sector, country and extreme weather event. These cases are used for drawing examples of 'best practice' as defined in later chapters. Moreover, this chapter provides a brief description of the cases to highlight the variety of approaches taken across the case studies. This addresses Task 1 as defined in the Terms of Reference for this project.

This chapter starts with a presentation of the process by which case studies were selected and continues with a brief description of the case (section 3.1). It then provides some initial observations on the characteristics of extreme weather insurance across the case studies (section 3.2).

## *3.1 Case study selection and description*

Here we describe the process used to select 12 case study countries and provide short descriptions of each of the 12 countries. Please see Annex 1 for more detailed per-country descriptions.

### *3.1.1 Case study selection process*

The selection of the 12 case study countries was based on a wide-ranging exploratory literature review and stakeholder engagement to gather a substantial amount of information on different insurance markets and sectors across the EU. The Terms of Reference (ToR) of this study listed the sectors agriculture, construction/building, energy, and transport as requiring study. These sectors were grouped under the labels agriculture, private households/buildings (private property insurance), and commercial insurance. The commercial insurance sector consists of policies that are sold to cover damage to business property (e.g. damage to energy infrastructure or vehicles) and business interruption costs (e.g. loss of revenue from breakdown of production machinery and business equipment). Commercial insurance would therefore cover the major impacts of extreme weather events on businesses such as energy and transport, as well as other business concerns.

When investigating how insurance provisions differ across the three sectors for all EU Member States, focus was put on the following extreme weather events: cloudburst or extreme rainfall (pluvial), fluvial flooding, coastal flooding, droughts and heatwaves, and windstorms. The only deviation between the extreme weather events listed above and in the ToR is that heatwaves are treated as a subset of droughts because droughts would primarily only be a concern for the agricultural sector. It should be noted that heatwaves could have a consequence on the transport or energy sectors via business interruption (i.e. railway tracks are no longer useable or power plants are not as efficient). Moreover, heatwaves could have larger impacts on society outside of those identified, through higher rates of excess mortality (McMichael et al., 2006). As a result, the impacts of heatwaves are more likely to be covered by health and life insurance, instead of insurance for extreme weather directly. The considerations of health and life insurance are different to those of non-life insurance where the focus is predominantly on the identified primary disasters. Therefore the emphasis here is put on non-life insurance such that all identified insurance schemes arguably have the same focus in terms of potential monetary impacts.

Once the first stage of the exploratory study was completed, the cases were refined to a short list of potential case studies. In order to refine the list of cases, this study employed the following selection criteria: geographical balance, wide coverage of extreme weather events, coverage of different styles of insurance provision, and coverage of different sectors. An additional selection criterion is the availability of sufficient data (as compared to the other potential case studies), which was used as the first selection criteria. Sufficient data availability was judged using the attributes as displayed in the attribute table (see Annex 1 for an example) for extreme weather insurance. The table was completed for each of the three sectors across the different extreme weather events for all EU Member States. Preference for inclusion as a case study was given to countries with more complete attribute tables and coverage of the majority of extreme weather events as listed in the ToR (collectively across sectors within a country). This step identified a potentially long list of viable cases.

The next step was to select a subset of the initial long list to match the geographical spread as required in the ToR. The wide geographical spread was achieved by splitting the EU into four quadrants (north, east, south and west) and selecting at least two countries located in each quadrant to act as case studies for that specific geographical sub-region. A short summary of case studies is shown in Table 3.1.

*Table 3.1: Selection of case study areas*

| Region | Private property | Commercial | Agriculture |
|---|---|---|---|
| **Eastern Europe** | Bulgaria<br>Hungary<br>Poland<br>Romania | Bulgaria<br>Hungary<br>Poland | Bulgaria<br>Hungary<br>Poland<br>Romania |
| **Northern Europe** | Denmark<br>Sweden | Denmark<br>Sweden | Denmark<br>Sweden |
| **Western Europe** | France<br>United Kingdom<br>Germany<br>Austria | France<br>United Kingdom<br>Germany<br>Austria | France<br>United Kingdom<br>Germany<br>Austria |
| **Southern Europe** | Spain<br>Italy | Spain<br>Italy | Spain<br>Italy |
| **Relevant extreme weather events** | Flooding (coastal, fluvial; pluvial)<br>Storms (wind; hail) | Flooding (coastal, fluvial; pluvial)<br>Storms (wind; hail) | Flooding (coastal, fluvial; pluvial)<br>Storms (wind; hail)<br>Droughts/heatwaves |

The selection criteria highlight positive reasons for selecting each country (or sector), recalling that cases have been selected to highlight differences in approaches.

### 3.1.2 Case study description

Brief summaries of the case study descriptions are presented below. More detailed versions can be found in Annex 1.

*Austria*

The opportunities for risk transfer in Austria are divided into two elements: a public mechanism in the form of a catastrophe fund and private insurance; these interact with one another. In Austria, many extreme weather events are insured on a voluntary basis, which many households in Austria have as a matter of standard practice. The exceptions are storms and hail, which are part of the standard property insurance (and a voluntary extension for businesses). The Austrian catastrophe fund provides compensation when other extreme weather events occur.

*Bulgaria*

Bulgaria has an insurance sector that is slightly less developed than other European countries (the participation rate is 2.1 % of per capita income vs. 7.6 % on average across the EU). The Insurance Act of 1997 was revoked due to the adoption of a new Insurance Code, which came into effect on 1 January 2006. Under this code, insurance companies can deal with extreme weather events by: setting higher solvency requirements; developing equalisation reserves; the use of reinsurance; and directly excluding extreme weather events from coverage. There is a strong international presence in the Bulgarian insurance market on the whole since foreign investors have acquired shares in most of the Bulgarian insurance companies or provide reinsurance.

*Denmark*

An increase in events and damages has made it important to establish an advance risk management system combining innovative insurance mechanisms, the participation of both public and private actors and their enhanced collaboration (as described during the stakeholder consultation). Denmark employs a mixture of compulsory and voluntary insurance. There is a tendency to move towards micro-rating insurance. After heavy floods in 2010 and 2011, many companies introduced restrictions on coverage. The penetration rate for private property storm insurance is over 90 % and for floods is 50-75 %.

*France*

France is characterised by a public-private sector partnership in providing affordable insurance and high penetration rates (~100 % for property insurance and ~50-75 % for business interruption), due to its focus on national solidarity and strong public sector influence. Since 1982, all households and business that enter into a contract of insurance covering damage to property or business are also covered against the effects of most major natural disasters (flood, drought, earthquake, etc.). This CatNat scheme covers the majority of extreme weather events (except storm, snow and hail) for private property, businesses and agricultural enterprises. The Regime des Calamites Agricoles (Agricultural Calamity scheme) offers specific compensation for non-insurable assets of farmers through the National Fund for the Management of Agricultural Risks.

*Germany*

Before the reunification of Germany there was a sharp divide between East and West Germany in terms of insurance for extreme weather events. In East Germany there was a state run monopoly with fixed flat-rate premiums, the purpose of which was the socialisation of losses in order to provide widespread extreme weather insurance for both property and contents. In West Germany, there was a combination of statutory public bodies, which acted as monopoly fire insurers, and private insurers. The premiums were permitted to be risk-based by the regulators, but both premium calculations and the terms and conditions of such policies were strictly supervised. After the German reunification in 1990, the fear of adverse selection was no longer viable due to the large number of policies in force in East Germany. The presence of many East German policies allowed for the creation of a sufficient risk pool, and general nationwide extreme weather insurance was allowed in 1991. After a major flooding in 2002 the estimated penetration rate of flood insurance (for example) was ~15 % (of private households). However, exposure to several other large-scale events, combined with attempts to increase risk awareness, has led to a penetration rate of ~40 % of households.

*Hungary*

While the percentage of premiums as a proportion of gross domestic product (GDP) is rather low in terms of coverage against extreme weather events, ~75 % of households with general private property insurance have coverage against flooding, storm and hail as a standard policy. In 2009, the overall size of the premiums collected by the Hungarian insurance market as a ratio to GDP was 3.3 %, which was in line with other central and eastern European countries, though smaller than the EU as a whole (which stood at 8.9 %). In terms of agricultural insurance, the scheme has undergone constant innovation in order to better develop into a viable solution for extreme weather risks. This has led to reform from a single compulsory policy to a partnership.

*Italy*

The general property insurance market in Italy is dominated by two firms (Generali and Unipol) that, between them, cover 70 % of the market. Natural disaster coverage is a voluntary extension of homeowners' insurance. The overall penetration rate is quite low due to low-risk perception and ad-hoc compensation. The majority of policies cover losses such as storms and hail, while flood insurance policies are less common. However, a flood in 2014 in Liguria and Emilia Romagna caused EUR 320 m in damages, of which EUR 140 m was compensated. Since 1970, agricultural risk management has been coordinated by the National Solidarity Fund (managed by the Ministry of Agriculture), the purpose of which is to support agriculture financial loss prevention. The National Solidarity Fund (NSF) has both *ex-post* and *ex-ante* roles. The *ex-post* role is to provide direct compensation, while its *ex-ante* role is to support insurance coverage or provide support for risk reduction (since 2004 this subsidy has become more decentralised, an example being the use of anti-hail nets). The NSF can contribute up to 80 % of the estimated insurance premium as a subsidy.

*Poland*

Due to the growing use of mortgages for new buildings, the insurance penetration rate reaches ~63 %, even if the purchase of disaster insurance is voluntary. Policies generally cover a bundle of extreme weather events but the size of coverage per policy may be limited. Compulsory insurance is, however, in place for agricultural farms whereby a comprehensive package of insurance (against a range of extreme weather events) for farm buildings in addition to the crops allows the farmer access to other avenues of governmental support. Despite the growing insurance coverage, the state can provide ad-hoc compensation for losses from extreme weather events resulting from repairing damaged infrastructure and homes. This compensation is a type of social assistance to satisfy basic living needs.

*Romania*

Romania can experience several natural perils, including earthquakes, floods and landslides. To provide owners of dwellings with cover for these, the government set up a compulsory insurance scheme in 2007. The scheme, called PRAC (Romanian Program for Catastrophe insurance), is built on principles similar to several other national catastrophe insurance schemes but with special features of its own, which include an important role for the insurance industry and the local authorities strongly involved in ensuring compliance. Since 2016, the insurance company Die Österreichische Hagelversicherung România has introduced an insurance scheme for farmers who are particularly affected by drought. Currently the penetration rate is low, which is partially explained by the company's recent arrival on the Romanian insurance market.

*Spain*

There are two bodies primary concerned with the management of insurance for extreme weather events. For private and commercial property there is the Consorcio de Compensacion de Seguros (CCS), while for agricultural insurance there is Agroseguro. Following reforms, there is currently a minimum level of protection required in an insurance policy against extraordinary risks (most extreme weather events but excluding hail, snow weight and common windstorms). The CCS is able to provide this statuary level of coverage on a subsidiary basis, i.e. if the insurer does not provide this coverage, that element is passed on to the CCS for a surcharge on the premium and a 5 % commission for the insurer. Agroseguro is a co-insurance pool of 29 companies including the CCS, where businesses can choose to integrate into the pool or not. Within the pool each company assumes risk in proportion to the share of total capital they contribute to Agroseguro. Unlike with the CCS, crop insurance is voluntary.

*Sweden*

Sweden relies on a private insurance market with little government interference to provide extreme weather event insurance. The Swedish insurance industry currently offers good coverage for all weather-related claims. Furthermore, the penetration rate is high with one of the reasons for this being that it is, in effect, compulsory for both private and commercial mortgages. Insurance companies in Sweden have so far been able to give good protection for all climate-related events through their basic insurance products.

*United Kingdom*

The insurance market here is free from government interference outside of general regulation. There have only been very rare cases of limited ad-hoc government compensation after a disaster. Therefore the insurance market is predominantly driven by competition between private insurance companies, whereby premiums are generally risk-based. However, many banks or mortgage providers require properties to have full insurance coverage in order for the loan to be provided. Many companies are involved in the general property insurance market.

### 3.2 Chapter conclusion: Case study market structures

The case study descriptions in the previous section highlight some of the major differences between countries in terms of how they approach insuring extreme weather events and that there can be differences between sectors.

On the whole, the case study insurance markets (across countries and sectors) can be divided into three broad groups following Hudson et al. (2017b): voluntary insurance, semi-voluntary insurance and mandatory purchase. In a voluntary insurance market a potential policyholder decides if they will buy insurance coverage and the insurer decides if they will provide the coverage. The semi-voluntary market is similar in that, in principle, both the insurer and policyholder can choose as to whether they will engage in the extreme weather insurance market or not. However, in practice this freedom can be curtailed in the sense that there is an unofficial compulsion from, for example, mortgage providers or an implicit contract between stakeholders that require the individual to take part in the insurance market. The mandatory markets are where the insurer or policyholder has a legal compulsion to take part in the market. For example, an insurer may be legally unable to refuse coverage against extreme weather events, while a policyholder may be compelled to buy fire insurance which has extreme weather insurance included.

From the broad inventory of insurance market data collected (see Annex 1) it was often found that the more mandated (i.e. the less freedom participants had in choosing to buy/sell extreme weather insurance) an insurance market was, the higher the degree of public sector involvement or support when compared to more voluntary markets. An additional structural feature tended to be that it was more problematic to privately insure extreme weather events that are more localised and less widespread across countries (river floods vs. windstorms). Thus several markets were found to have explicit market features geared towards providing insurance for these truly extreme local events.

These divisions hold across the sectors studied and can potentially result in quite different outcomes for the individual markets. This is because the different approaches studied highlight the different rationales behind the provision of extreme weather insurance. For example, the compulsion to buy or to provide insurance can result from the belief that coverage should first and foremost be widespread across the population for a low premium. In contrast, more voluntary-based markets see extreme weather insurance as a tool for risk management, providing strong incentives for a policyholder to manage their own risk. The following chapter presents selected market outcomes for the case study countries and sectors that will feed into the identification of best practices.

# 4. OVERVIEW OF INSURANCE MARKET PERFORMANCE AND COST-EFFECTIVENESS OF INSURANCE MARKET APPROACHES

The main objectives of this chapter are as follows: to present our definition of insurance cost-effectiveness and the main criteria upon which markets will be judged upon (section 4.2); to provide a detailed overview of the insurance market outcomes for the selected criteria (section 4.3); and a discussion of the measures that can be undertaken by policyholders to limit risk, and the mechanism by which insurers can promote their use (section 4.4). This addresses Tasks 1, 2a and 2b as detailed in the Terms of Reference.

This chapter builds on the data collected and presented in the previous chapters and also presented in Appendices 2 and 3. It provides a detailed description of the findings used as the core input into the multi-criteria analysis conducted in Chapter 5, and for this reason it does not draw overall conclusions.

## *4.1 Definition of the process chain in extreme weather insurance*

For extreme weather insurance to be provided, the risk posed by the extreme weather events must meet the following conditions (Charpentier, 2008):

1. Actuarial insurability
    - The extreme weather event occurs randomly (i.e. a certain probability within a year).
    - The maximum possible loss should be reasonable compared to an insurer's solvency conditions.
    - The loss should be identifiable and quantifiable.
    - The losses should be relatively uncorrelated so that risks can be pooled following the law of large numbers.
2. Economic insurability
    - There should be limited consequences from information asymmetries (i.e. moral hazard and adverse selection).
    - The willingness of consumers to pay for an insurance policy should exceed the premium for which insurers are willing to accept the risk transfer.

When these conditions are met, a viable insurance market for an extreme weather event can be provided. The actuarial insurability criteria result in the insurer understanding the risk in monetary terms, while the economic insurability criteria allows the market to find a 'fair' price that results in a market equilibrium of supply and demand. Meeting these conditions can vary across extreme weather events and locations. Widespread events (e.g. windstorms) can more easily meet the requirements of the law of large numbers as compared to more localised events (e.g. fluvial floods), which can result in highly correlated claims.

The actuarial insurability criteria can be met through the development of natural disaster risk modelling to better understand the range of possible losses and their relative likelihoods. Maintaining, improving and sharing knowledge can help maintain the insurability of extreme weather events as the stakeholders are not 'surprised' by events and can plan accordingly. The applicability of the law of large numbers may be more difficult to maintain; however, structuring products correctly or by introducing novel mechanisms can help create a suitable pool of policyholders.

The economic insurability criteria can be hard to meet as a result of a potential mismatch in risk perceptions between an insurer and a potential policyholder, resulting in the two sets of stakeholders not having sufficient overlap between what they find an acceptable premium for the risk transfer to take place. The presence of information asymmetries creates problems with the insurability criteria as it means that the premiums charged do not reflect the actual risk a policyholder faces, limiting the attractiveness of a policy for a policyholder or worsening loss outcomes for an insurer.

The insurance sector by itself is able to act in such a way as to meet some of the aforementioned criteria. However, the insurability criteria can be achieved through wide-ranging stakeholder consultation and involvement in the risk management process. The risk management process is split into risk transfer and risk reduction. The two are not independent of each other and can interact in either a positive or negative way (Hudson et al., 2017b).

## *4.2 Methodology: Definition of cost-effectiveness of insurance mechanisms*

One proposed measure of the cost-effectiveness of insurance is the ratio of damage suffered to premiums paid. This ratio could indicate whether it is cheaper to transfer or retain risk. However, it is also an unreliable metric if based on observed data. This is because the observed losses are very volatile. In some years, insurance will appear very expensive when there are no extreme weather events or only small hail or windstorms (for example). While, for example, in years with major flood events, premiums would look relatively cheap. For instance, in 2015, EU-wide total property insurance premiums[9] equalled about EUR 92 bn, with reported 2015 extreme weather losses equalling about EUR 7 bn, which corresponds to a ratio of 8 %, while in 2013 it corresponded instead to about 30 % (Insurance Europe aisbl, 2016).

Moreover, it should be noted that, in the long run, insurance is more expensive than the total value of the risk that is transferred (if connected to risk). While in theory an actuarially fair insurance premium is equal to the annual expected damage, in reality the insurer must charge loading factors on top of the expected damage in order to remain viable (diverging from the risk faced). A risk-averse policyholder will still buy insurance if the premium loading is not too high because the financial certainty that insurance provides maximises welfare compared with facing the uncertain loss.

Another indicator of cost-effectiveness could be the premium relative to the impact of an extreme weather event. This would show the relevant benefit of being insured when a large event occurs. Table 4.1 indicates the percentage of the loss caused by a 1/500-year (yr) flood (shared over the population affected by a 1/500-yr flood) that is equal to the average private property insurance premium (for households). The 1/500-yr flood has been selected as it represents a large-scale flood that is not often directly protected against. The data in Table 4.1 argues that while an insurance premium may be larger than the annual expected loss, insurance becomes truly important when very large disaster events occur. These are the events where it is often not economically desirable to build prevention infrastructure (i.e. the total discounted welfare benefits are smaller than the total discounted investment and maintenance costs). While different extreme weather events may have different values associated with the 1/500-yr event, they will present the same thinking in that they convert the possibility of a large random monetary loss for a known and fixed smaller loss. In this case, a comparison of premiums with the risk level may also be a suitable indicator if the pricing structure of the premium is relatively transparent, as the relative probability of extreme events is also an important influence.

Insurance has attracted much policy attention as a tool for building resilience to extreme weather events by providing financial compensation for losses and incentives to reduce risk.

[9] Total premiums are used due to the common practice of product bundling.

Insurance shares the financial risk across policyholders, and risk-based premiums can incentivise risk reduction by individual policyholders (Hudson et al., 2016). However, insurance becomes less attractive for high-risk households when premiums reflect the underlying risk (Botzen et al., 2009a). Although lower risk policyholders have a weaker incentive to reduce risk, they can be more likely to buy insurance since premiums are more affordable.

This trade-off between premium affordability and risk reduction incentives is an important, yet difficult, challenge for insurance companies to balance, and is often influenced by different risk management objectives (Kunreuther, 1996; Botzen et al., 2009b; Kunreuther and Michel-Kerjan, 2009; Mechler et al., 2014; Penning-Rowsell and Pardoe, 2012; Surminski and Oramas-Dorta, 2014). The differing risk management objectives of the stakeholders show that there would be room for more open and transparent engagement of, and collaboration with, the various stakeholders involved in the risk management process.

***Table 4.1: The ratio of average private property insurance premiums to the losses included during a catastrophic flood event***

| | Average private property insurance premium per capita (EUR/yr) | The ratio (as a percentage) of average private property insurance premium to the modelled damage caused by a 1/500-yr flood per household exposed |
|---|---|---|
| **Bulgaria** | 90 | 80% |
| **Denmark** | 290 | 92% |
| **Germany** | 225 | 74% |
| **Spain** | 150 | 60% |
| **France** | 250 | 87% |
| **Italy** | 80 | 31% |
| **Hungary** | 100 | 66% |
| **Austria** | 320 | 99% |
| **Poland** | 30 | 19% |
| **Romania** | 30 | 32% |
| **Sweden** | 250 | 89% |
| **United Kingdom** | 275 | 92% |

*Source: Attribute tables located in Appendix A. The 1/500-yr loss is taken from: http://wri.floods.org, last accessed on 18 July 2017, converted into Euros from dollars.*

A range of risk management objectives could also be identified from stakeholder consultation(s) during the study[10]:

[10] These views are drawn from our own stakeholder consultation in addition to the individual consultation responses on the Green Paper (that were published in English) that can be found at: http://ec.europa.eu/finance/consultations/2013/disasters-insurance/contributions_en.htm

- Insurance can make two key contributions to risk management in addition to risk transfer: increasing risk awareness and providing incentives for risk reduction.

- Insurance should function in a way that keeps claims and losses within acceptable limits (as subjectively defined by the various stakeholders).

- Policyholders will be compensated for losses: quickly, efficiently, reliably and fairly. Premiums and deductibles should be affordable and the policies should cover all aspects of an event's consequences.

- Insurance should be provided in a manner that creates a wide pool of policyholders to make premiums affordable. However, the use of insurance should also be accompanied with stricter building restrictions and/or standards to correct the imperfect risk signal of non-risk based premiums.

- Insurance can be used to promote preparedness for disaster events and to help limit the impacts afterwards.

- The insurance mechanisms in place should send policyholders a risk signal regardless of whether the decision to purchase insurance is voluntary or mandated.

- Insurance should be widely available, in a competitive market place, while being based on premiums that reflect risk. However, to achieve this outcome the state may have to act in a role that enables the industry to overcome barriers regarding premium setting and the general uncertainty surrounding natural disaster risks.

Looking across the range of perspectives, the differences between risk management objectives highlight the complexity of comparing different insurance schemes. Countries have developed different approaches because they have displayed different risk profiles and priorities in the past, leading to their idiosyncratic development (Surminski et al., 2015). A comparative analysis of schemes is therefore required that focuses on cost-effectiveness, the extent to which a scheme is able to achieve its objectives.

Instead of basing cost-effectiveness on the size of premiums relative to losses or risk, the cost-effectiveness of an insurance scheme can be judged on affordability, availability, penetration rates and risk reduction incentives, which is more in line with commonly stated objectives of natural disaster insurance mechanisms. In addition, the efficiency of insurance should be considered within the broader framework of disaster risk management as a tool for adaptation (based on the collective input from the project's opening workshop). The framework can have several insurance-specific focuses. Examples could be: increasing the coverage against extreme weather events, the speed of compensation and the solvency of the sector. Cost-effectiveness in the context of insurance scheme reforms is often evaluated by the penetration rate, that insurance provides a signal to guide risk reduction or risk management more generally, the insurance industry is able to absorb large losses, and claim payments are certain and fast (see e.g. Schwarze and Wagner, 2007; Paudel et al., 2012; Poussin et al., 2013, DEFRA, 2011; EC, 2013; Michel-Kerjan and Kunreuther, 2011). These findings are combined in five criteria on which the cost-effectiveness of insurance schemes is analysed:

- the insurance penetration rate (i.e. the percentage of potential policyholders with an insurance policy);

- the ability of insurance to act as a signal of risk or to promote risk management and preparedness;

- the ability of the insurance sector to absorb large losses (such as the Solvency II requirements);

- the ability to provide quick and certain compensation payments after a disaster event;
- the affordability and availability of insurance policies / premiums.

A further condition for the cost-effectiveness of insurance would be the presence of moral hazard and adverse selection (or charity hazard). These factors are, however, not directly studied as consistent information is not available across the case studies. Such a qualitative review is presented in section 4.3.6.

## 4.3 Summary of insurance market outcomes

The different market structures in the 12 elected case studies are evaluated according to five key insurance market outcomes that are later used as the key criteria for identifying best practices. The five key outcomes are: insurance penetration rates (coverage gaps), risk signalling and risk reduction incentives, the affordability and availability of insurance, the speed of payments, and the overall solvency of the insurance mechanism. Additional key concerns are adverse selection, charity hazard and moral hazard, which can impact the successful operation of insurance mechanisms as a tool for managing natural disaster risk.

### 4.3.1 Insurance penetration rates and coverage gaps

Insurance penetration was defined to be the percentage of potential policyholders that holds the insurance policy. This is opposed to the percentage of damage covered by insurance policies. This definition is used due to the ubiquitous presence of insurance deductibles. Therefore the coverage gap is defined within this study as the number of potential policyholders without insurance for private property insurance, or as the percentage of arable land that is not insured for agricultural insurance.

*Private property*: There is a large variation in insurance penetration rates across Europe. It was noted in previous chapters that the case studies can be separated into three broad market classifications: voluntary (Germany, Austria, Italy and Bulgaria); semi-voluntary (Denmark, Sweden, Poland, Hungary and the UK); and mandatory (France, Spain and Romania). The case studies are allocated to a market classification according to what risks are automatically included in the insurance policy and the 'mandate' to buy insurance. Figure 4.1 (left) highlights the purchase requirement for the households (to buy private property insurance coverage) and Figure 4.2 (left) highlights the insurance penetration rate as averaged over extreme weather events. For instance, a flood insurance penetration rate of 80 % and a windstorm insurance penetration rate of 40 % result in an average penetration rate of 60 %.

There is a roughly equal spread between countries with a formal mandate[11] (three cases), an informal mandate[12] (five cases) or voluntary purchase decisions (four cases). There are four cases where the average penetration rate (across extreme weather events) is over 85 % of homeowners, five cases with an average penetration rate of between 50 % and 75 %, and three cases with an average penetration rate below 20 %.

The countries with the highest penetration rate tend to be the countries with mandatory and semi-voluntary insurance markets; the voluntary markets tend to score lower. There are exceptions however, as Romania with a 'mandatory' market has a very low penetration rate due to the lax enforcement of the regulations.

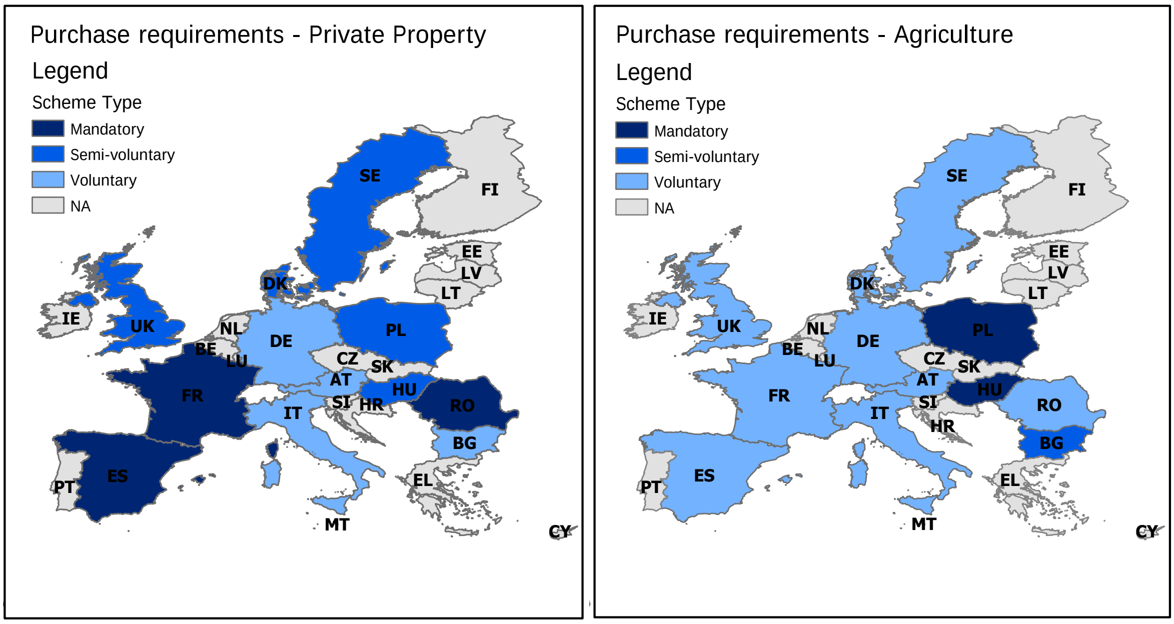
[11] In the case of a formal mandate neither insurers nor policyholders could refuse insurance coverage, i.e. there are compulsory extensions to offer insurance or legal requirements to buy.

[12] In the case of an informal mandate, in principle consumers can choose if they wish to buy insurance coverage, but many are in practice required to purchase coverage, for example due to mortgage conditions.

*Commercial*: Information on the penetration rate of extreme weather insurance in the commercial sector is much scarcer. In terms of property losses, where information was available, it appears that storms are still the most commonly insured against extreme weather event, as is also the case with private property insurance for households. France and Spain achieve roughly comparable penetration rates with private property insurance due to the compulsory extension on insurance coverage, while Austria has slightly lower penetration rates than was the case for private property insurance. Similar to that observed for private property insurance, penetration rates for commercial extreme weather insurance are likely to be higher when the decision to buy or provide insurance is guided by (in)formal[13] rules on insurance purchase.

*Agriculture*: Hail is the most commonly insured against disaster event for the agriculture sector. Multi-peril insurance coverage is only rarely offered in the case study countries. The vast majority of crop insurance markets are based on voluntary insurance purchases (nine cases, 75 %). Only two countries have mandatory insurance for farms over a certain size (Hungary and Poland, 17 %). Bulgaria is the only case where a semi-voluntary approach could be identified because without insurance coverage, farmers did not have access to government subsidies.

***Figure 4.1: Summary of purchase requirements: private property (left) and agriculture (right)***



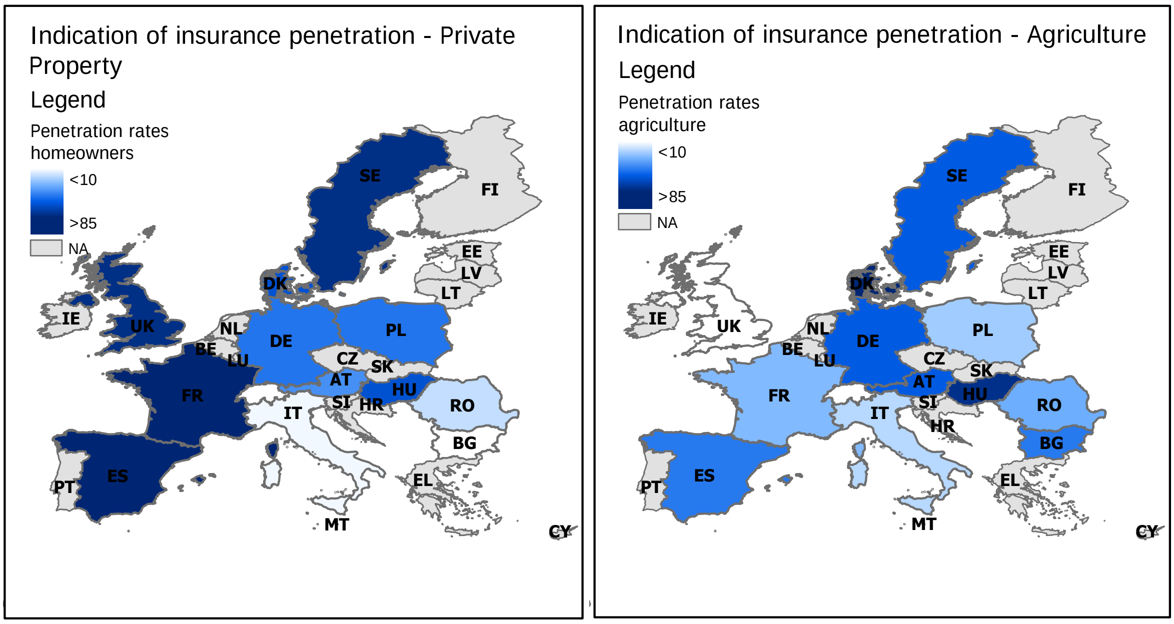

Hungary, Austria and Spain provide multi-peril insurance coverage, with relatively high penetration rates. Hungary's penetration rate is over 80 % due to its mandated nature, while Austria has a penetration rate of 60 % (80 % for only hail) and Spain just over 30 % with voluntary purchase decisions. We therefore do not see a strong difference between the outcomes of a mandatory vs. voluntary market in these cases.

The remaining countries tend to only have substantial coverage for hail (e.g. Germany and Sweden with an insurance penetration rate of about 60 %). Romania and Bulgaria also have penetration rates of approximately 50 %, despite the different market classifications. The UK has the lowest level of coverage with a penetration rate of about 7 % for hail risks.

[13] A compulsion to buy coverage through legal requirements (e.g. compulsory extensions) or through other requirements (e.g. mortgage loan requirements).

It appears that unlike private property insurance, the decision to buy agricultural insurance is not strongly driven by the market structure. This is also highlighted by the observation that several countries offer premium subsidies for crop insurance. The countries with no identifiable practice of subsidising premiums are Bulgaria, Denmark, Sweden, the United Kingdom and Germany. There are varying penetration rates of between 7 % (UK) and 60 % (Sweden and Germany). The remaining countries subsidise premiums with rates of between 40 % and 65 %, while the corresponding penetration rates varied between 24 % (Poland) and 60 % (Austria). There is a great deal of variety between and within the two groups of countries who do or do not provide premium subsidies, which makes it hard to draw conclusions on the relative success of providing premium subsidies.

***Figure 4.2: The average insurance penetration rates across extreme weather events for private property (left); the percentage of arable land that is insured against at least one extreme weather event (right)***




### 4.3.2 Risk signalling and risk-reduction incentives

These two features of extreme weather insurance are important in determining what role insurance plays in adapting to changing patterns of risk (beyond the mechanism of transferring risk). Risk signalling represents the ability to increase awareness and understanding of the threats facing a (potential) policyholder, while the ability to incentivise risk reduction could promote policyholders to more proactively manage their risk profiles.

These measures are described in more detail in the following section.

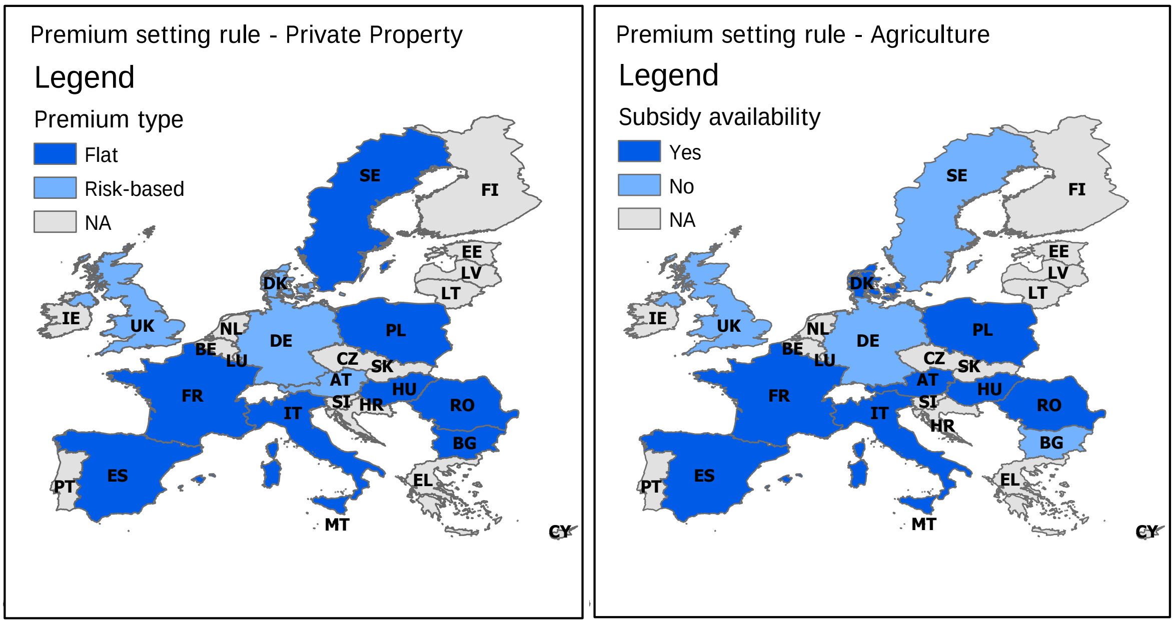
*Private property and commercial:* There are specific examples of where individual insurance markets have attempted to foster risk reduction by directly promoting resilience through risk reduction certificates (as with the GDV for example) or indirectly through discussion, which puts risk reduction on the agenda of stakeholders, and increasing risk awareness through information sharing platforms (such as HORA as led by the Austria Insurance Association).

Figure 4.3 highlights the, effectively, limited spread of risk-based premiums as only four countries were identified as employing such premiums (33 % of cases). The remaining 67 % of cases employed flat rate premiums (or very limited risk differentiation). Additionally, even in the countries that used risk-based premiums there are cases where in very high flood risk areas the premiums are relaxed to flat rates. This is the case for policyholders ceded to Flood Re in the UK or the Danish storm surge insurance. This highlights a relatively limited ability for insurance premiums to directly signal risk.

The risk-reduction incentives most systematically present are policyholder deductibles. Nearly every case study (83%) displayed the use of deductibles (Figure 4.4). However, for the most part, the deductibles found are small (e.g. EUR 380 in France per year). The deductible has the effect that the policyholder has invested money, which provides a financial incentive to limit damage. Wind or hail storms tend to have the smallest deductible, while floods tend to have the largest.

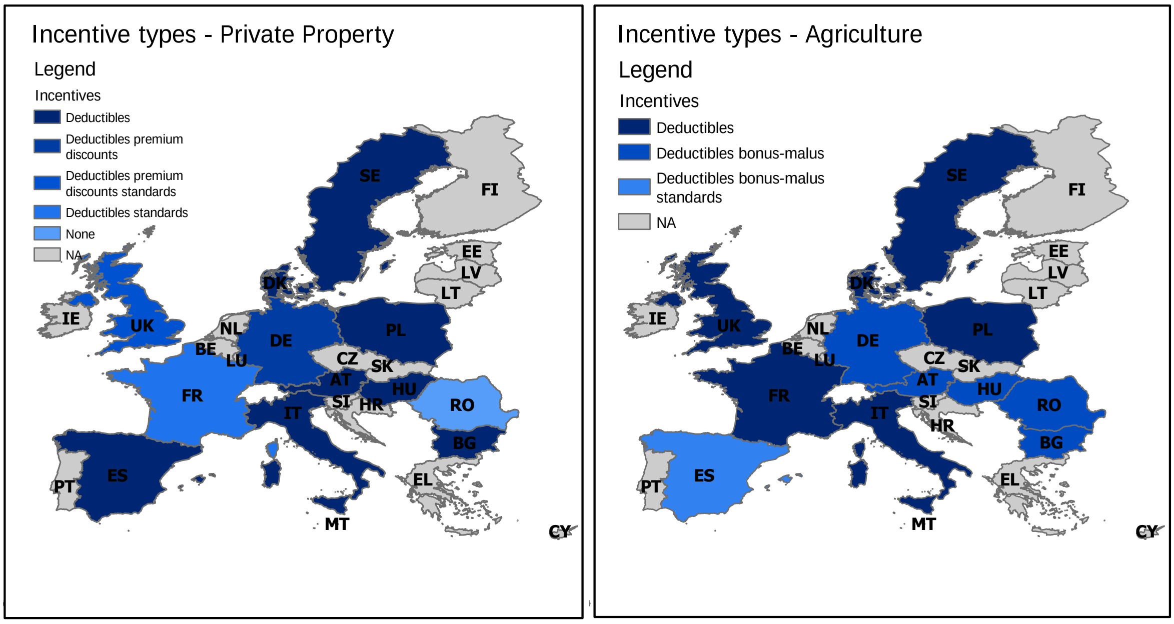
Neither Spain nor Romania provide direct policyholder incentives for risk reduction as both see risk reduction as the role of the state (even though there are potential risk-reduction measures that can be employed), as revealed during the stakeholder consultation. The Spanish approach relies on education to make policyholders aware of their risk and the ways that they can manage it. In both cases, this absence of incentives may be due to the strong solidarity focus of extreme weather insurance in these countries.

***Figure 4.3: Premium setting rule for private property insurance (left) and agricultural insurance (right)***




<u>Agriculture:</u> Of the 12 case study countries, 50 % (or six) focused risk management upon deductibles. The most commonly identified deductible amount was around 10 % of the total insured crop value. However, the deductible for various crops could vary quite largely. Cereal crops tend to have a lower deductible (or none in the case of the UK) as compared to higher deductibles for fruit or vegetables. Five of the countries (or 42 %) use both a deductible and a bonus-malus system. Therefore, the premiums of following years were in part determined by the policyholders' recent claims. This promotes risk reduction because policyholders with consistently low claims records would be rewarded with lower premiums. In Spain, both deductibles and a bonus-malus system are used in addition to imposing certain minimal risk management activities. Moreover, premium discounts are given in Spain for hail risk-reducing measures (i.e. hail nets) and other minimum standards to be insured are applied for hail. Figure 4.3 indicates a roughly equal spread of premiums that are either risk differentiated or flat rates. Moreover, there is a roughly equal spread of countries that offer subsidies for agricultural insurance premiums.

*Figure 4.4: Mechanisms linked to insurance to lower risk in private property insurance (left) and agricultural insurance (right)*




### 4.3.3 *Affordability and availability of insurance*

The affordability and availability of insurance are hard to assess systematically across the case studies. Affordability is a normative concept and views on this can differ quite strongly across the case study areas. Hudson et al. (2016) use a residual income approach to define whether premiums are unaffordable or not. In that case, a premium is judged to be affordable when disposable income minus the insurance premium and expected deductible value is larger than the national poverty line (assuming a constant distribution of income across a country). Other studies proposed definitions that take into account the expenditure of rent or a simple percentage of income. However, a common point is that the definitions are based either on the ability of a policyholder to pay the premium or the burden that a premium places on their budget.

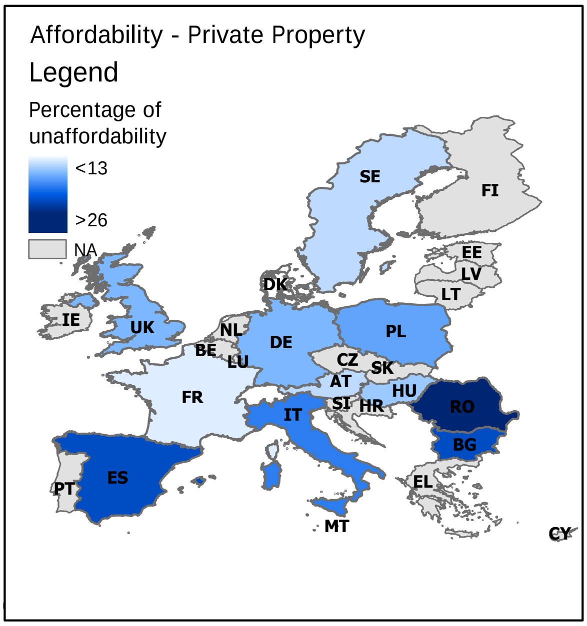
*Private property*: In most cases, the full range of extreme weather events can be insured as an extension of general property insurance across the case studies. The cost of the extension is quite low (~EUR 50) in low-risk areas. Following the Hudson et al. (2016) definition of unaffordability, it is likely that 20 % of the low-risk population will deem insurance (as a whole) unaffordable in the eastern European cases, 14 % in northern Europe, 16 % in western Europe and 21 % in southern Europe (Figure 4.5). This produces an average rate of 18 % (with a standard deviation 3.9%), with a minimum value of 13 % (Denmark) and a maximum value of 26 % (Romania).

However, premiums tend to differ where there are high flood risks (of various types), which implies premiums are more likely to be unaffordable for certain income groups in areas with a high flood risk. The availability of insurance does not seem to be a pressing concern in low-risk areas, but in higher risk areas the presence of higher premiums can act as a disincentive for purchasing insurance. Not purchasing the insurance implies that the households who remain in the area bear the risk themselves. Therefore the above indicators can be considered as showing a minimum rate of unaffordability.

The market structure or premium setting rule does not appear to bear a strong connection with the unaffordability of insurance. For example, the flat rates in Spain (23 % unaffordability rate) or France (14 %) can be roughly similar to overall risk-based premiums in the UK (17 %

unaffordability rate). This can indicate that the problem with insurance unaffordability is not the size of the premium itself but the low income and related purchasing power of a household.

***Figure 4.5: Indicators of affordability across the case study countries***




*Note: percentage of households for whom private property insurance is unaffordable according to the Hudson et al. 2016 definition.*

*Commercial and agriculture*: Debates on affordability of insurance usually focus on households. Commercial insurance premiums are often unknown, which makes it difficult to judge their affordability, as well as the potential requirement for affordability to be defined differently. Agricultural insurance seems to be most often available as hail insurance, with occasional extensions into other hazard events (i.e. the multi-peril products available in Austria, Spain or Hungary). This could mean that in some cases it is not possible to insure against other extreme weather events (for example, flooding in the UK or Germany). The premiums as a percentage of the total insured value for agriculture insurance appear to be higher than those for private property insurance. Several studies (Mahul and Stutley, 2008) show that the transaction costs involved with this type of insurance are quite high, leading to an increase in overall premiums. This may result in problems with affordability, but many countries try to overcome this with rather large subsidies for agricultural insurance premiums to lower the effective price that farmers pay, namely subsidies are between 40 and 65 % of the premium in the case studies that offer such subsidies (e.g. in Italy). However, in order for a government to provide premium subsidies of 65 % an insurance policy must only start providing compensation for losses once a loss of at least 30 % of the historical average has been suffered. Lower levels of subsidies can relax this condition.

### *4.3.4 Speed of payments*

The speed of payment corresponds to the speed at which compensation is paid to those affected by an extreme weather event. This includes the time given to claim processing (i.e. the insurance company receives and assesses the claim) to when the claim is confirmed and the indemnity transferred to the policyholder.

*Private property and commercial insurance:* There is a large degree of variation between cases in the speed of insurance payments. The length of time from claim processing to payment tends to be within 15 to 30 days. Despite the different stylised insurance markets across the case studies, there does not appear to be a strong link between how a market is structured and how quickly compensation is provided.

*Agriculture insurance:* The majority of case studies aim to provide the compensation payment at around harvest time, with the aim of providing the compensation to the policyholder within 1 month after harvest at the latest.

Overall, the various insurance markets across the case studies have a long tradition of providing insurance and have developed mature insurance administration processes, or engage in cross-border business; agriculture hail insurance has been offered since the 19th century in some cases. This means that the administrative processes for providing compensation once the claim has been processed can be rather quick. Nevertheless, some stakeholders raised concerns about the speed at which claims are processed given the need to assess and adjust the damage suffered, because most insurance policies are indemnity-based.

### 4.3.5 Ability to absorb large losses

The ability to absorb large losses is discussed at the national level instead of across sectors because the separate insurance lines of business cannot be considered independently of one another (Figure 4.6, however, presents the separate approaches graphically). It must be noted that when the insurance sectors′ ability to absorb large losses is discussed that due to the Solvency II regulations, each insurance body will have to have a regulator accepting 0.5 % annual insolvency probability or lower, which can be met via premiums, capital reserves or reinsurance. The particular combination depends on the individual preferences of the company in question. Therefore the insurers should be able to absorb a loss of a return period of once in 200 years. This should allow the industry to be financially stable. Loss events far in exceedance of the one in 200-year standard may require more government support to absorb the losses, as insurers are not required to plan for these events.

Figure 4.6 presents how the case study countries support the financing of extreme weather events. In eight (67 %) of the cases the industry is predominantly reliant on reinsurance for the private property sector. These cases also tend to not have a strong governmental presence in their markets; the UK complements private reinsurance with a specific pool and levy for high flood-risk households (which is in turn privately reinsured). Denmark also has a pooling approach for storm surge insurance financed by a levy on fire insurance policies, though unlike the UK this pool has been offered a limited guarantee by the Danish Government. France and Spain mainly support the financing of large losses via public reinsurance with an unlimited guarantee (to be called upon when the insurance body no longer has sufficient resources). The Spanish approach mainly relies on the equalisation fund of the CCS, which it can choose to support with private reinsurance. However it has not yet done so.

The right panel of Figure 4.6 highlights the various approaches for absorbing large losses for crop insurance. Again, 67 % of the markets are reliant on only private reinsurance. The remaining 33 % of countries have access to public support for all risks (Hungary, Spain through the CCS) or a specific risk (droughts in Poland).

Figure 4.7 presents the countries where the government has provided compensation after an extreme weather event. The sample is equally split between those that do offer the potential for compensation and those that do not. Half of the countries which do offer compensation from a disaster fund did so on an ad-hoc basis. The use of ad-hoc (rather than predetermined strategies) can result in uncertain compensation arrangements, as their ad-hoc nature does not entail offering a victim of an extreme weather event a specific amount of compensation within a specific timeframe.

***Figure 4.6: How case study countries support the financing of extreme weather events through reinsurance (private property, left; agriculture, right)***

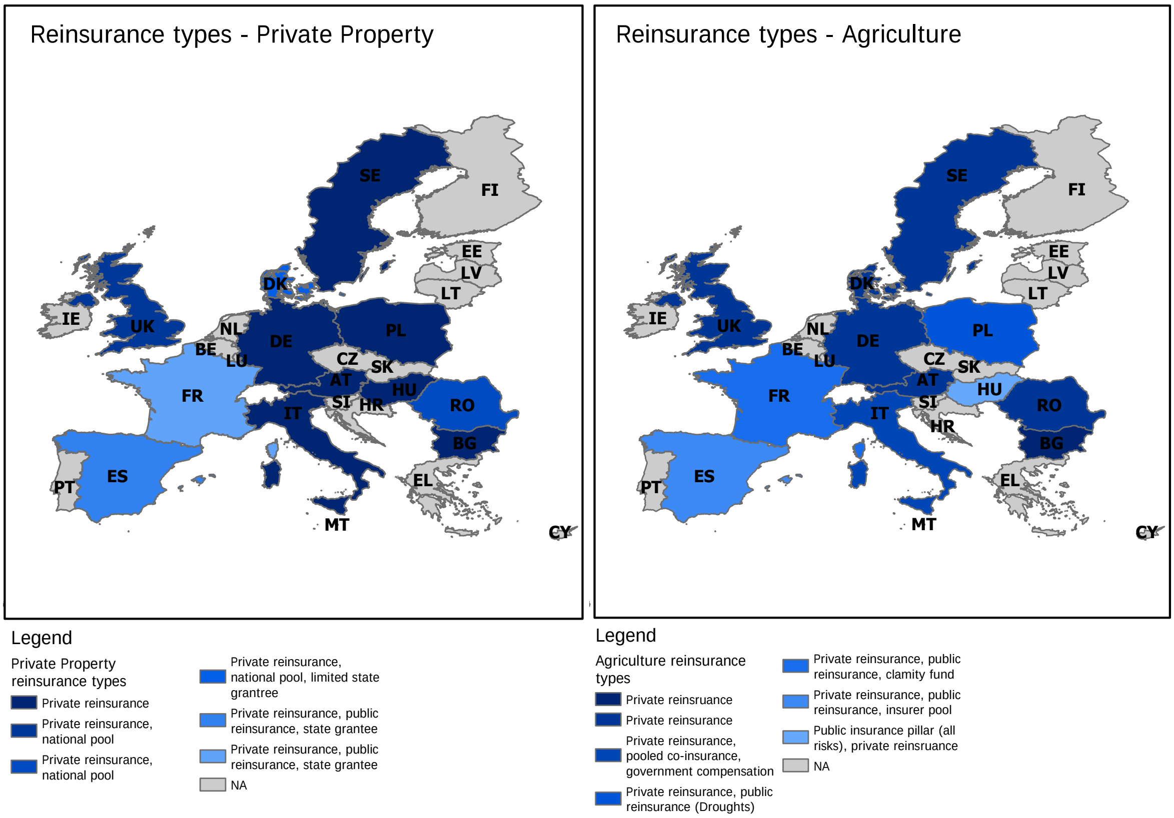
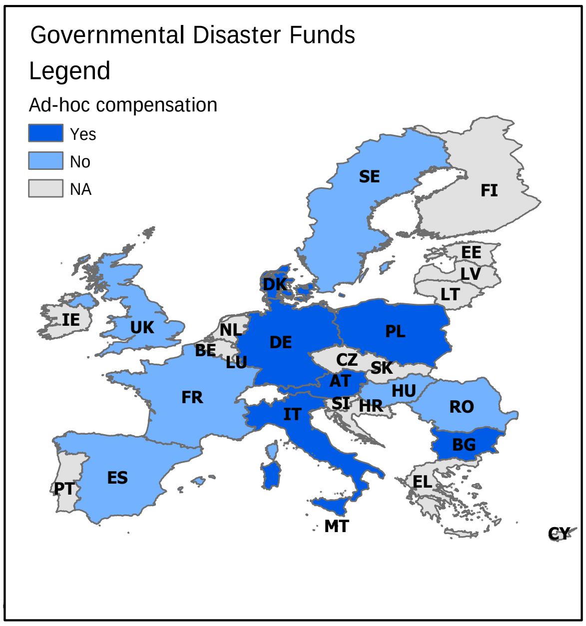



***Figure 4.7: Case study access to government-provided disaster funds***



### 4.3.6 *The presence of moral hazard, adverse selection and charity hazard*

While not formally part of the cost-effectiveness assessment, these three features (moral hazard, adverse selection and charity hazard) are important considerations. This section discusses their likely presence in the case study countries.[14] In the insurance market there is often asymmetric information between buyers (policyholders) and sellers (insurance companies). In such a market, problems of adverse selection and moral hazard can occur. Adverse selection could adversely affect the penetration rate, and hence indirectly their affordability. Moral hazard may adversely affect the incentives of policyholders to take private protection measures.

*Adverse selection*:

Adverse selection is a typical problem in insurance markets that may lead to the collapse of the market or even prevent the market being established in the first place (Akerlof, 1970; Rothschild and Stiglitz, 1976). In the case of a natural disaster risk, a property owner may be better informed about the potential damages to his property due to flooding, windstorms or cloudburst than the insurance company, which may only have data on regional average damages. In such a situation, property owners with far below average risks may be unwilling to buy insurance at the price of the community rating. If equilibrium exists, only high-risk property owners will purchase insurance at high premiums. But it may also be that a market does not exist in these circumstances (Rothschild and Stiglitz, 1976). The presence of such private information is more likely for some extreme weather events than others. For example, the risk of flooding is obviously higher for people living on flood plains than for people living outside such areas, and exposure to heatwaves is more likely in cities than in rural, green areas.

Empirical research on the issue of adverse selection in insurance markets has focused on the observed correlation between insurance coverage and risk claims, controlling for all relevant policyholder characteristics that are observable to the insurer. Cohen and Siegelman (2010) conducted a comprehensive review of empirical studies, testing the presence of adverse selection in different insurance markets. They concluded that the existence of adverse selection varies across individual insurance markets and even across segments of the same market. With respect to voluntary flood insurance in Europe, it has been argued that adverse selection is one of the reasons for low market penetration rates in some areas (Schwarze and Warner 2007; Seifert et al., 2013). In an attempt to shed more light on this issue, Hudson et al. (2017b) analysed field survey data of around 2 000 flood-prone households in the Elbe and Danube river catchments that were collected by Kreibich et al. (2005; 2011) after the flood events of 2002, 2005 and 2006. Statistical analyses showed that insured households had a higher exposure (inundation level) and higher financial damage than uninsured households, suggesting the presence of adverse selection.

*Moral hazard*:

Unlike adverse selection, moral hazard has to do with 'hidden action' after the policy has been bought. Moral hazard occurs when people invest less in risk reduction after they purchased insurance, and if financial incentives for policyholders to limit risk are insufficient. For example, moral hazard can arise when insured individuals expect compensation for damage regardless of their risk mitigation efforts.

The recent literature has stressed that individuals are often not fully rational and act upon their own beliefs, which may be inaccurate. Moreover, private decision-making may not be limited to financial calculations alone, but may be influenced by social norms and feelings about risk, like minimising worry. More recent theoretical work has shown that if such behavioural drivers are

[14] As is encouraged under Task 2 of the Terms of Reference.

accounted for, moral hazard and adverse selection may not arise because highly risk-averse people may both purchase insurance and invest in risk reduction (de Meza and Webb, 2001). Moral hazard has been investigated in the academic literature across natural disasters and countries. Yamori et al. (2009) found no real systematic differences between the degree of policyholder self-protection between Japanese policyholders who had earthquake insurance, fire insurance, or where uninsured. Lindell and Hwang (2008) and Lindell et al. (2009) investigated the correlation between holding earthquake insurance and employing risk reduction measures for US households, finding a positive relationship. Hudson et al. (2017b) and Osberghaus (2015) investigated the same relationship for households in different regions of Germany and both found no evidence for moral hazard being present. Carson et al. (2013) and Petrolia et al. (2015) investigated the relationship between risk-reduction measures and windstorm insurance for the US, finding once again the absence of moral hazard.

The results are highly consistent across different markets and countries, and therefore it is likely that decisions to reduce natural disaster risks and to buy insurance are jointly taken and are mainly driven by internal (behavioural) characteristics of individuals who face low-probability/high-impact events such as floods (Hudson et al., 2017b). Such risks are often misperceived, and individuals often do not use traditional rational decision-making models in preparing for such risks.

*Charity hazard*:

One reason that has often been put forward to explain a low penetration rate of natural disaster insurance in voluntary markets is the so-called 'charity hazard', i.e. '[…] the tendency of individuals to not to insure themselves against possible natural disasters because they believe help will be available, e.g., from friends, family, the municipality, charity, or state emergency programs.' (Browne and Hoyt, 2000, p. 293). The bulk of the literature has focused on post-disaster government compensation as a source of charity hazard.

Charity hazard has also been identified as a cause for lower spending on private protection measures by households (Kelly and Kleffner, 2003). Post-disaster government compensation is widespread in the USA and the EU. Government relief programmes include the EU's solidarity fund, or the Austrian catastrophe fund (Katastrophenfonds). Other countries, such as Germany and Poland, have on occasion compensated victims of natural disasters on an ad-hoc basis (Raschky et al., 2013; Botzen et al., 2009). The theoretical case for an adverse effect of post-disaster compensation is clear when an individual believes that government compensation will cover (a fair part) of his losses in the case of a disaster, perceiving it as a 'premium-free insurance', which is more attractive than market insurance premium or costly self-protection and insurance (e.g. Kelly and Kleffner, 2003; Raschky and Weck-Hannemann, 2007).

The empirical evidence on charity hazard is less clear. Research in the USA (Kunreuther et al., 1978; Browne and Hoyt, 2000; Petrolia et al., 2011) usually rejects the charity hazard hypothesis in the case of flood risks. This is not surprising because US households are obliged to purchase flood insurance in order to become eligible for federal disaster assistance after they have experienced flood damage and were not insured. In Europe, some studies found evidence in favour of the hypothesis. Asseldonk et al. (2002) found evidence of charity hazard in a study that elicited the willingness-to-pay of a sample of Dutch farmers for a hypothetical crop insurance scheme. Botzen and van den Bergh (2012a; 2012b) found a negative effect of government compensation on the willingness-to-pay of Dutch homeowners for a hypothetical flood insurance, and Botzen et al. (2009) also found that post-disaster compensation can reduce incentives for self-protection (e.g. sandbags, water-resistant floors). Raschky et al. (2013) argue that the design of post-disaster compensation schemes can make a big difference in their effect on charity hazard. To test this presumption, they compare the institutional scheme for disaster relief in Austria, with the scheme in Germany. The scheme in Austria assures partial compensation, while the scheme in Germany is more generous but uncertain (ad hoc). Raschky et al. (2013) find that for a random sample of households in Austria and Germany in communities that were affected by the 2005 'Alpine' floods, willingness-to-pay for flood insurance is much more negatively affected by the certain but incomplete Austrian scheme than by the complete but uncertain German scheme.

*Mitigating adverse selection, moral hazard and charity hazard*:

*Adverse selection*: Adverse selection occurs due to informational asymmetries as the insurer is unable to fully identify high and low risks, which causes the overall pooling mechanisms employed to collapse. Adverse selection is fundamentally a data awareness issue and can be addressed through the improvement of risk modelling combined with the transparent sharing of data across all participants in the market. These actions will reduce the information difference between the stakeholders that leads to adverse selection. Therefore platforms such as HORA or Zurs can address adverse selection by acting as an information platform. However, it must be noted that the sharing of information is of key importance as otherwise the informational asymmetry falls too strongly on the insurer who may be better informed than the potential policyholder. The agricultural sector for crop insurance tends to require one of the following two options: either a farmer must insure all fields of the same crop or he must insure all of his arable land. These mechanisms force the farmer to insure both high and low-risk areas rather than only insuring the areas at highest risk.

*Moral hazard*: Moral hazard is generally addressed in insurance markets due to the introduction of a deductible, as this is a payment that the policyholder must make before compensation for damage experienced by the policyholder is provided. Therefore the policyholder has invested money and thus has an incentive to manage potential impacts (Hudson et al., 2017b). However, Hudson et al. (2017b) provide some indication that deductibles may not be successful at promoting disaster preparedness unless they are very large. Large deductibles, however, can limit the effective insurance coverage provided or the attractiveness of such a policy.

*Charity hazard*: Charity hazards can be prevented if governments do not provide direct disaster compensation after large disaster events. However, such compensation payments can be attractive for politicians, in election years (e.g. Cole et al., 2012; Fuchs and Rodriguez-Chamussy, 2015). Therefore rules must be in place to prevent governments from providing ad-hoc disaster compensation. Formal rules or prohibitions can signal government commitment to no longer provide such ad-hoc compensation. Alternatively government compensation could be provided by loans instead of grants, because government compensation through loans has been shown to not reduce insurance demand (Kousky et al., 2017). An additional direction for mitigating charity hazard could be establishing very formal and published rules, allowing insurers and public compensation bodies to work in concert by each providing coverage for different layers of damage by extreme weather events; such a policy is recommended in several studies (e.g. Botzen and van den Bergh, 2008; Mechler et al., 2014).

### 4.3.7 Initial conclusions based on insurance market outcomes

In reviewing the findings from the attribute tables located in Appendix A it is clear that there is no single country that performs best on each of the five studied outcomes. Therefore, when judging for best practice in the following chapter, the outcomes of a specific case study will have to be viewed holistically across the indicators using a multi-criteria analysis (MCA). Moreover, once well-performing cases have been identified, several cases may need to be compared to one another so that we can find the common characteristics between them. In doing so conclusions on what tends to work well could be identified, as well as possible limitations that the best-case countries overcame.

### 4.4 Summary of mechanisms to incentivise risk reduction

Hudson et al. (2016) state that the relevance of providing financial incentives to promote individual flood-risk adaptation can be found in the observation that few floodplain inhabitants voluntarily invest in cost-effective flood-risk mitigation measures (e.g. Kreibich et al., 2005). Such behaviour can be explained by several individual decision-making processes (Kousky and Cooke, 2012), for example, many individuals underestimate flood risk and the benefits of reducing it (e.g. Bubeck et al., 2013; Poussin et al., 2014). Offering premium discounts means that the decision to invest in disaster risk-reduction by policyholders is simplified to comparing the costs of the measure with the premium discounts instead of the perceived risk-reduction benefits, which are often underestimated. Moreover, such discounts imply that the benefits of reducing risks are transferred to the policyholder instead of accruing mainly to the insurance company in terms of lower claims. Yet, the effectiveness of such financial incentives has hardly been studied empirically (Surminski, 2014). However, many insurance schemes have other mechanisms in place to promote policyholder risk management.

#### 4.4.1 Overview of insurance mechanism for promoting policyholder risk reductions

Section 4.3.2 highlights the possible mechanisms that insurers have used systematically across the case study countries. In this section, these mechanisms are discussed in more detail with a judgement on their potential effectiveness as a risk-reduction mechanism. The focus is on how insurance acts as a signal or incentive mechanism, and not on how many households have undertaken measures because of these mechanisms due to limited data availability across the case studies.

The following mechanisms have been found, during the inventory of insurance markets, to be used by insurers to prompt their policyholder to conduct more active risk management (with the aim of lowering the risk faced):

- **Premium discounts** – This means that the insurance company provides premium discounts when a policyholder has implemented risk-reduction measures to their insured property.
    - Likely to have a medium effect at promoting risk reduction: this is because a policyholder is provided with a tangible value for the benefit of employing the risk-reduction measure. This can overcome concerns regarding the behavioural heuristics of policyholders, such as an underestimation of the benefits of risk reduction, and implies that the benefits of risk reduction accrue to the policyholder instead of only to the insurance company. Therefore policyholders could more often employ a measure where it is cost-effective. However, the effectiveness is limited in practice because setting up and monitoring a system of individualised premium discounts in return for the constant employment of such measures can entail transaction costs that may render such incentives uneconomically viable.
- **Deductibles** – The policy is issued with a fixed deductible. The potential residual loss per claim is assumed to promote the policyholder to manage their risk. Additionally, deductibles can also change in accordance with the claims made. This means that the deductible of the policyholder will be adjusted according to the implementation of risk-reduction measures. This mechanism works two ways: on the one hand, the insurance company can increase the deductible when the policyholder doesn’t implement any risk reduction measures; on the other hand, the deductible can be decreased in support of the implementation of risk-reduction measures by the policyholder. Moreover, the presence of a deductible results in the policyholder having invested money and provides an incentive for continued risk reduction.

- Likely to be not effective (small deductible size, low awareness) to having a low effect (large deductible size, high awareness). The deductible is not a strong incentive for risk management as it relies on the expected policyholder's retained loss and their individual coping capacity to spark a risk management decision. Therefore deductibles may be large to provide a stronger signal to policyholders but this in turn lowers the attractiveness of the policy, although it could make the premium more affordable.

- **Risk-based premiums**: The price of the premium is strongly connected to the expected annual loss from the range of extreme weather events that will be insured against.

  - Likely to have a low effect. Risk-based premiums by themselves can raise risk awareness, resulting in indirect risk reduction (if the premium is transparent regarding the source of risk). However, they can cause very high premiums in high-risk areas, limiting the resources available for employing risk-reduction measures, unless premiums are reduced when such measures are implemented. The effectiveness of this mechanism will be enhanced if combined with premium discounts.

- **Terms and conditions requirements** – This implicates that a policyholder can only obtain coverage or more favourable coverage conditions when they meet certain risk-reduction conditions (i.e. the implementation of risk-reduction measures) as required by the insurance company.

  - Likely to have a medium effect. It may be less effective in locations where insurance is voluntary since it imposes additional costs on the policyholder (i.e. they are required to retrofit their buildings). Depending on the size of these costs it may reduce the attractiveness of insurance coverage. However, such terms and required conditions could be integrated in overall building codes or construction practices, so that newly constructed buildings automatically comply.

- **Awareness campaign** – Informational campaigns (e.g. using hazard maps and local risk information) that are aimed at increasing the level of risk awareness or the perceived benefits from insurance or undertaking various preparation measures. A successful campaign should lead to more agents preparing for extreme weather events. Moreover, such campaigns can allow those affected to 'build back better' if they are made aware of the appropriate methods for reducing risk or boosting their overall resilience.

  - Likely to have a low to medium effect. The campaign must be continuous in order to prevent behavioural heuristics returning expectations to pre-campaign levels. However, the effectiveness is still reliant on the subjective decisions of the target audience about risk reduction.

- **Bonus-malus** – The policyholder is rewarded with lower premiums for a period of consistently low losses, while constantly high losses increase the premium.

  - Likely to have a low to medium effect. The main limitation of this mechanism is that it is difficult to connect specific risk management measures undertaken by the policyholder with changes in losses rather than a period of good fortune. The main influence of this incentivising mechanism is likely to occur in the end. Ultimately the inter-annual variability of losses is likely to average out, resulting in a lower average annual loss for those policyholders who manage their risk or exposure better than other policyholders. Therefore, the time frame over which policyholder losses are included in the bonus-malus calculation is important for the effectiveness of this mechanism.

While these mechanisms are used across Europe, knowledge of their success is limited because there are few records of how systematically these measures have incentivised a reduction in vulnerability. Instead there are a limited number of localised studies of how many at-risk households have employed natural disaster risk-reduction measures (e.g. Kreibich et al., 2005; Bubeck et al., 2012; Poussin et al., 2014). Nevertheless, there is a nascent literature studying the potential of such mechanisms to incentivise policyholder risk reduction (e.g. Hudson et al., 2016). Instead of an empirical assessment we have made a qualitative ranking of how likely they are to be effective. In doing so we highlight that because many households exposed to extreme weather risks tend to underestimate the threat, mechanisms that rely on the internal behaviour of an agent are unlikely to be very successful. For example, a deductible of EUR 380 a year for a policyholder who expects to only be flooded once in 1 000 years is unlikely to incentivise any additional risk management. However, more solid and tangible incentives, such as premium discounts or requirements, can overcome this problem as the decision to employ a risk-reduction measure is simplified and based on more tangible benefits and requirements than reduced expectations of risk. There may be scope for a reassessment of the role of such incentivising measures in the future, as insurers may be better able to use their expertise in assessing and transferring risk. This can be done in collaboration with an organisation(s) that plays a stronger role in promoting policyholders to lower risk. For example, closer collaboration and data/information exchanges between major stakeholders could allow insurers to employ risk-based premiums to signal risk, while another offers direct incentives for risk-reduction measures (e.g. building codes enforced by the government), that are then reflected in lower insurance premiums.

### *4.4.2 Potential measures for reducing extreme weather risk that can be taken by policyholders*

Table 4.2 provides an overview of the preventive, or risk reducing, measures per hazard that policyholders could implement and their costs. The table summarises the different measures that policyholders could employ and highlights their ability to reduce risk; it is followed by a brief discussion of the measures. The uptake of the measures listed below could be more or less successfully promoted by insurer-provided incentives, based on the strength of the incentive and the level of risk a policyholder faces. The measures are often very specific for an area and are influenced by local hazard conditions.

***Table 4.2: A list of potential risk-reduction measures***

| Strategy and examples | Description | Investment costs | Risk-reduction estimates |
| --- | --- | --- | --- |
| **Wet-flood proofing** | Attempts to limit water damage once floodwater has entered a building | €1 602 - €6 355 | Likely to have a low-to-medium effect |
| **Relocate furnace and other utilities** | Furnace and other utilities are relocated above the expected flood level, resulting in no water damage | | |
| **Openings in basement or garage** | Let water enter the building at the expected flood elevation level to prevent collapse of the structure | | |

| Strategy and examples | Description | Investment costs | Risk-reduction estimates |
|---|---|---|---|
| **Water-resistant materials** | Apply water-resistant materials where floodwater is expected within the structure | | |
| **Relocate furniture** | Household contents/furniture are moved above the expected water height | | Likely to be effective |
| **Dry-flood proofing** | Attempts to prevent water entering a building | €6 176 - €9 369 | Likely to be highly effective |
| **Backflow valve** | Prevents water from entering a building through the sewer and drains | | |
| **External coating or covering** | Prevent floodwater entering through walls | €14 - €41 per metre | |
| **Shields for openings** | Prevents floodwater entering through openings, such as doors and windows | €87 - €279 each | |
| **Reinforce walls** | Protect walls from collapsing with the buoyancy force of floodwater | | |
| **Elevation of buildings** | Attempts to prevent water from reaching a building | | Likely to be highly effective |
| **Elevation of existing buildings** | Elevation of existing buildings using stilts, or elevation of staircases shafts etc. | €24 763 - €27 802 | |
| **Elevation of new buildings** | Redesign new buildings using stilts or additional filler/sand, so that they are elevated during their construction | €812 – €5 705 | |
| **Mounds** | Elevate the land under the property above extreme storm elevation | | |
| **Floodwalls** | Construct a wall around the property to prevent water reaching the structure | | Likely to have a medium effect |
| **Private floodwalls** | Build a floodwall with a height ranging between 0.6 m and 1.8 m around the land. Might require a sump pump to remove seepage and internal drainage | €225 – €477 per meter | |
| **Mobile floodwalls** | Install the infrastructure for temporary floodwalls | €157 per meter | |

| Strategy and examples | Description | Investment costs | Risk-reduction estimates |
|---|---|---|---|
| **Wind proofing** | Structural mitigation measures attempting to lower the physical vulnerability of buildings against windstorms | | Likely to have a medium effect |
| **Bracing of gable-end roofs** | Help to fortify vulnerable roof components and provide greater resistance to hurricane-force winds | | |
| **Roof tie-down clips** | Roof tie-down clips connect the roof deck to a building's framing; these clips provide a continuous load path from roof to foundation. This helps to increase the building's resistance to hurricane-force winds | | |
| **Reinforced concrete roof deck** | A solid slab of concrete capping the top of a house increasing its storm wind resistance. | | |
| **Roof-to-wall connection: Clips** | Pieces of metal nailed into the side of the rafter/truss and into the side of the top plate or wall stud | | |
| **Roof-to-wall connection: Single wraps** | A single strap attached to side and/or bottom of top plate and nailed to the rafter/ truss | | |
| **Roof-to-wall connection: Double wraps** | Straps attached to side and/or bottom of top plate and nailed to the rafter/truss | | |
| **Shutters: Intermediate type** | Shutters strong enough to protect windows | | |
| **Hail-proofing** | Structural mitigation measures attempting to lower the physical vulnerability of buildings against hailstorms, including placing thicker glass in greenhouses | | Likely to have a medium effect |
| **Re-roof** | Re-roof buildings with hail-impact-resistant material | | |
| **Protective shields** | Install protective shields for rooftop equipment | | |
| **Impact-resistant glass** | Wind-resistant glass to | | |

| Strategy and examples | Description | Investment costs | Risk-reduction estimates |
|---|---|---|---|
| | prevent windows breaking and causing water or wind damage indoors | | |
| **Hail-protection nets** | Nets to protect fruit trees from hail damage | | |
| **Drought-proofing** | Attempts to protect crops from the impacts of drought | | Likely to have a low-to-medium effect |
| **Climate-resilient crop types** | Changing crop varieties to more climate resilient crop types | | |
| **Enhancing soil's organic carbon** | Improve the soil's resilience by increasing the organic carbon | | Up to 70 % of price and weather risk |
| **Improved tillage practices** | Improve tillage practices to conserve soil water and to decrease levels of transpiration | | |
| **Irrigation system** | Reduces reliance on precipitation or natural reservoirs using irrigation | | |
| **Intercropping** | Mix crop varieties to increase the resilience of crops and the soil | | |
| **Altering sowing time** | Change the growing season, limiting exposure to water and heat stress | | Stronger effect in southern Europe (around a 15 % increase in yield as compared to a baseline for most crops) than in northern Europe (around a 2 % increase), and for durum wheat |

*Sources: Aerts et al. (2013); Cong et al. (2014); FEMA (2008); Howden et al. (2007); Hudson et al. (2016); Iglesias et al. (2009); National Drought Mitigation Center (1998); Rollins and Kinghorn (2013); Ye et al. (2016); http://www.hurricanescience.org*

<u>Flooding</u> (including pluvial, fluvial and coastal floods)

Wet-flood proofing: these measures attempt to minimise the damage inside a property once floodwater has entered. Measures in this category are likely to have a low-to-medium effect, as they don't prevent water from entering the building but aim to minimise the damage and aim to prevent the collapse of the building as a result of hydrostatic pressure.

Dry-flood proofing: these measures attempt to prevent water from entering the building. Measures in this category are likely to have a medium effect because they aim to prevent water from entering the property. The efficiency of measures in this category is limited by the extent to which the flood depth exceeds the height of dry proofing.

Elevation of buildings: measures in this category attempt to prevent water from reaching the building and thus are likely to be highly effective. Flood damage can still occur if the flood depth exceeds the property elevation height, but measures related to the elevation of buildings will still significantly decrease the overall damage.

Floodwalls: a wall constructed around the property to prevent floodwaters from reaching the property. Measures in this category are likely to have a medium effect because they aim to prevent water from entering the property. The efficiency of measures in this category is limited by the extent to which the flood depth exceeds the height of the floodwall and by the extent to which the wall is strong enough to withstand the water pressure. Besides the wall itself, it is necessary to take measures to control for seepage and to drain the area within the floodwalls.

<u>Storms</u>

Wind-proofing: structural mitigation measures attempting to lower the physical vulnerability of buildings against windstorms. Measures in this category are likely to have a medium effect because they include relatively minor adjustments that strengthen the structure of the property, making it more resistant to substantial gusts of wind.

Hail-proofing: structural mitigation measures attempting to lower the physical vulnerability of buildings against hailstorms. Measures in this category are likely to have a medium effect because they include structural measures that aim to decrease the physical vulnerability of the property. Similar measures can be employed in order to protect agriculture.

<u>Droughts</u>

*This category only applies to the agricultural sector.*

Drought-proofing: measures attempting to protect crops from the impacts of a drought. Measures in this category are likely to have a low-to-medium effect because they require long-term and very substantial changes in irrigation practices and crop- and soil-management.

### *4.4.3 What preventive measures are associated with extreme weather event risk reduction at a larger scale?*

Insurance can provide incentives for policyholder-level risk reduction. However, there is also an interaction with larger scale risk-reduction measures. This is because if government-provided risk reduction lowers the potential impact of extreme weather events, then insurance premiums and/or deductibles should fall. Moreover, very high insurance premiums or the lack of available coverage in an area can provide an indication of the desirability of implementing risk-reduction measures in such an area. These measures can be most useful when there is a healthy degree of interaction between the private and public sector in order to guide larger scale risk-management attempts to where it is required. This can imply a 'contract' between the government and the insurance sector. In this 'social contract', the government reduces risk (by investing in risk-reduction measures that pass a cost-benefit analysis) and the remaining risk can be transferred and shared by the insurance sector.

For example, the household-level impacts from floods, windstorms or hailstorms could be reduced by altering building codes so that the base vulnerability of buildings is reduced. Similarly, zoning regulations can alter land-use patterns so that land in high-risk areas is transferred to uses that result in less damage if a natural hazard occurs. These are particular risk-reduction measures where governments and insurance sector stakeholders can collaborate.

### *4.4.4 Initial conclusions regarding insurance-based incentives*

This section presents the finding that insurers have a range of mechanisms to promote policyholder-level risk management, and the policyholders themselves have a range of measures that they themselves can employ. However, it is seen that while there is a range of mechanisms that insurers have at their disposable, there is a very strong focus on providing indirect risk management signals (which are likely to be of low effectiveness themselves). The majority of markets combine deductibles and awareness campaigns to highlight the risk that policyholders still hold after buying an insurance policy. A wider range of incentivising strategies could be employed; however introducing such strategies could be quite costly (thus limiting the strategy's attractiveness), or go against the disbursement methods or channels of providing insurance (and hence coverage) but limit the individuality of policies (i.e. off-the-shelf online policies as compared to bespoke policies). Moreover, where incentives are provided it is difficult to judge how well the incentives have worked in practice due to limited information on policyholder-level preparedness. Nevertheless, it can be assumed that an insurance sector that employs a wider range of mechanisms is relatively more successful at promoting risk management strategies.

However, while insurance policy-level incentives may not have appeared to be highly successful, close collaboration between the various stakeholders can help to improve overall societal resilience. For example, an agreement to provide insurance so long as there is a certain level of risk reduction pre-existing in an area. In the next chapter, the cost-effectiveness of insurance (including risk reduction) is discussed and by means of a multi-criteria analysis, the 'best' and 'worst' practices from the 12 case study countries are identified.

# 5. GOOD PRACTICE FOR THE COST-EFFECTIVENESS OF INSURANCE MARKET APPROACHES

This chapter evaluates and discusses elements of cost-effectiveness of the climate and weather-related insurance schemes for households and agricultural enterprises that are present in our 12 case study countries. It thereby identifies 'best' and 'worst' cases and discusses options for improvement. Thereafter, we focus on the cases with the two highest scores for a given weighting scheme (representing different potential objectives). We find that the case studies overall (for both the household and agriculture sectors) do not incentivise risk reduction as strongly as they could do. This highlights a particular direction in which insurance markets could be reformed to further adapt to changing patterns of risk.

## *5.1 How to determine good practice or the cost-effectiveness of insurance*

The MCA focuses upon the household and agriculture sectors for the following reasons. The focus emphasises the differences between the two styles of insurance. While commercial insurance tends to be a bit more flexible than household insurance (for which we had information), their characteristics of provision seemed quite similar overall. Moreover, the information collected on the commercial sector was the most 'patchy' in terms of content, preventing a full analysis in comparison to the household and agriculture sectors.

These criteria, noted in the previous section, are used to evaluate the cost-effectiveness of insurance schemes: overall penetration rate; risk signalling or risk reduction; ability to absorb large losses; provide quick and certain compensation; affordability and availability. The evaluation is based on the multi-criteria analysis (MCA) framework, as presented in Hudson et al. (2017c). An MCA-based approach is used because the five evaluation criteria cannot be considered independent of each other in evaluating which scheme represents 'best practice'. All evaluation criteria play a role and may be important for the evaluation.

An example of the method is shown in Equation (2):

$$\mathrm{S^1}_{\mathrm{c,s}} = \sum_{\mathrm{i=1}}^{\mathrm{i=5}} \omega_{\mathrm{i}}^{1} \mathrm{MCA}_{\mathrm{c,i}} \tag{2}$$

$\mathrm{S^1}_{c,s}$ is the overall score for country *c* and sector *s* under risk management objective 1 (superscript 1, weighting scheme 1). This score is the weighted sum of the individual criterion scores (i) for country *c* ($MCA_{c,i}$). The weights ($\omega_i^1$) are defined per risk management objective and may differ per criterion or over three different weighting schemes to highlight potentially different objectives. For example, the same insurance product may fulfil a policy objective related to solidarity and coverage, while it does not score well from the point of view of risk management. The three key objectives to study will be based on the following weighting schemes shown in Table 5.1:

- Weighting scheme 1: Solidarity and coverage. Providing a high degree of coverage and affordable insurance matching the idea of insurance as a social or public good[15].
- Weighting scheme 2: Balanced objectives. This is based on seeing insurance as a private good[16] and is a summary of the different objectives of relevant stakeholders[17].

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[15] Whereby insurance is seen as a method of protecting society as a whole by limiting the individual financial impacts, thereby preventing economic damage from extreme weather events and should be accessible for all, or that there is a strong overall desire that all are covered.

- Weighting scheme 3: Risk management and adaptation incentives. This scheme focuses on the ability of insurance to act as an adaptation signal or risk management incentive.

***Table 5.1: The three weighting schemes to match the three key problems***

| | Weighting scheme 1 | Weighting scheme 2 | Weighting scheme 3 |
|---|---|---|---|
| **Objective** / **Criteria** | Solidarity and coverage | Objectives balanced across stakeholder views | Risk management and adaptation incentives |
| **Insurance penetration rate** | 0.35 | 0.23 | 0.125 |
| **Risk signalling** | 0 | 0.22 | 0.5 |
| **Ability to absorb large losses** | 0.15 | 0.19 | 0.125 |
| **Affordability and availability** | 0.35 | 0.19 | 0.125 |
| **Quick and certain compensation** | 0.15 | 0.18 | 0.125 |

*Notes: Schemes 1 and 3 are based on expect judgement; Scheme 2 is based on aggregating views from the stakeholder consultation. Numbers may not total to one due to rounding.*

The individual criterion scores ($MCA_{c,i}$) are scored based on a points scheme developed by expert judgement, such that the better the case study's performance on that outcome the more points are awarded to that sector (see Appendix 4). The next step regarding the $MCA_{c,,i}$ scores is to standardise the scores to a more comparable basis. There are two different standardisation systems used, both of which are used to determine the set of countries that are determined to be best practice. These are noted in Appendix 4.

## 5.2 *Outcome of the MCA: best practice*

Table 5.2 highlights the overall outcome of the MCA by noting the cases where they were the two highest scoring countries on either of the two ranking systems of the household and agriculture insurance sector[18].

[16] Whereby insurance is seen as a method for protecting an individual financially from extreme weather events based on their own wishes.

[17] This was based on the stakeholder consultation process, whereby many stakeholders were asked to value the relative importance of the outcomes. Expert judgement was then used to aggregate these responses into an overall weighting scheme.

[18] The individual sector scores are presented in Tables 6 and 7.

***Table 5.2: Summary table of the 'first' and 'second' best outcomes in the household and agriculture sectors***

| | **Household** | | **Agriculture** | |
|---|---|---|---|---|
| | *First best* | *Second best* | *First best* | *Second best* |
| **Weighting scheme 1** | France | Spain/UK | Austria | France/Sweden |
| **Weighting scheme 2** | France/UK | | Austria | Spain |
| **Weighting scheme 3** | Denmark/France/UK | | Spain | Austria |

*Notes: Shared boxes indicate either an equal score or that a country was in first or second place depending on the ranking system used.*

### *5.2.1 Household sector*

*Denmark:* Denmark is placed second best (together with France and the UK) on weighting scheme 3 (under the relative ranking system) based on its ability to signal risk and incentivise climate adaptation. Denmark scored high on having risk-based premiums (other than for coastal flooding), using deductibles as well as incentivising adaptation through a number of different initiatives. However, as can be seen from the value presented in Table 5.6 and Table 5.7 under this weighting scheme that there is still much room for improvement, the performance of Denmark was slightly above average on the risk reduction aspect, combined with a high performance on the other four evaluation criteria rather than acting as an example of outstanding risk incentivisation.

An interesting feature of the Danish case is that it scores highly on the affordability criteria (with the lowest rate of unaffordability of all case studies) due to the combination of high incomes and the structure of the market for flood insurance. The current Danish approach was developed because flood insurance (primarily coastal flooding) was considered unaffordable leading to the establishment of the Storm Council in 1990. The Storm Council decides whether a storm surge has taken place and thereafter handles cases involving compensation following flooding from waterways and lakes, as well as subsidies for reforestation after windfall. It is appointed by the Danish Minister for Business and Growth and consists of an independent chair and eight other members. Its members represent insurance companies, citizens, municipalities and ministries. This set-up provides inclusion of a broad range of stakeholder who can bring a holistic view on reducing risks, covering damages and avoiding moral hazard. The Storm Council's compensation is financed by a yearly fee of EUR 4, which is included in the insured's fire insurance policy. The fire insurance is mandatory when owning a property, which also explains Denmark's high penetration rate and scoring under this criterion. Furthermore, with a formal mechanism and clear definition of an event required for payouts, Denmark scores high on the criteria of compensation payments.

In order to avoid moral hazard, the Storm Council is based on two principles. The property owner is responsible for making the necessary and reasonable investments in prevention and it is therefore important to incentivise these measures. The second is that the event is considered to be extraordinary to ensure that the property owner manages more common impacts. It is decided that a 1/20-year event is an appropriate level of coverage

On the private insurance market, risk-based premiums are becoming more and more common in Denmark along with posing conditions to the policyholder. What can be seen throughout the insurance scheme and initiatives in Denmark is that there is a broad range of stakeholders involved on numerous different initiatives. An example of this is how insurance companies and municipalities are working together, both in the Storm Council and also when preparing and implementing the climate adaptation plans. This ensures active stakeholders that have a strong buy-in to the processes and who can streamline the different initiatives, such as payment of damages from floods and the preparation of climate adaptation plans.

*France:* The French household insurance sector ranks first in weighting scheme 1 as it provides a high insurance penetration rate and available and affordable insurance products. The property insurance penetration rate reaches 100 %, providing coverage to all households against all climate-related risks. The average annual premium for a basic household insurance policy is around EUR 250 (including around EUR 25-30 for CatNat). The insurance is unaffordable for only 14 % of households because the total premium paid is larger than what low-income households can afford. The CatNat premium itself is rather small, but it is the combination with general household insurance that pushes up the rate of unaffordability.

The high penetration, availability and affordability are ensured by a strong influence from the public sector, through a regulatory framework that provides for mandatory insurance, product bundling, state-regulated flat-rate premiums, and a state guarantee for reinsurance. The system is structured such that private insurers are obliged to provide coverage against more general and spatially diverse risks of windstorms and hail, which is in practice bundled with the mandatory property insurance. In that way, a high penetration rate is ensured and affordable premiums are provided as there is a sufficiently large pool of high and low risks.

The CatNat regime covers uninsurable extreme weather events such as floods, which are generally more localised in specific areas or regions compared to windstorms, for example. CatNat is a compulsory extension to property insurance, provided by private intermediaries through a flat-rate surcharge over existent policies against property damages (i.e. 12 % of the property insurance premium). The government sets the level of both premiums and deductibles by decree, ensuring affordability and reflecting the national solidarity dimension of the regime. Therefore, France scores highly on the first scheme because the government selected the right structure mechanisms to provide affordable insurance in an enforceable manner.

The French household insurance sector ranks first in weighting scheme 2 because it scores well on all other cost-effectiveness criteria. A key element of the second scheme is the ability to provide quick and certain compensation, and absorb large losses. France's relatively good performance stems from the mixed system involving both public and private insurance sectors. The system relies largely on the private insurance sector to manage and pay compensation claims in the case of an extreme weather event. The reason is private insurers are the main intermediary between those affected and indemnity payments, which provides a strong business case for providing quick compensation due to potential reputational losses. For CatNat compensation to be paid to an insured household, the extreme weather event needs to be declared as a natural disaster by an inter-ministerial decree, noting the causal connection between the event and the damage suffered. The process is initiated by local authorities and submitted to the government representative; the decision is made by an inter-ministerial commission, based on objective meteorological and geological data (as defined by law). Once a declaration has been made the insured has the responsibility to file a claim within 10 days; the insurer must make a first deposit within 2 months and disburse the claim payment within 3 months of the claim or decree. The current framework does not provide all the necessary suitable guidance to ensure full certainty of compensation. In particular, the current framework does not provide a list, and the definition of natural hazards covered by the regime and the notion of uninsurable damages resulting from abnormal intensity of natural hazards leaves room for subjective interpretation. Nevertheless, there is likely to be a tendency to err on the side of generosity rather than caution, due to the underlying political solidarity philosophy. There have been previous failed attempts to more clearly define the scope of the regime.

Another key feature of the French regime is that it provides for a public reinsurance scheme in order to ensure its financial sustainability. Insurers are free to choose a reinsurance scheme, but the Caisse Centrale de Reassurance (CCR) benefits from the state guarantee and offers unlimited reinsurance coverage in the framework of the CatNat regime. So far the insurance sector has shown the ability to absorb large losses. The equalisation reserves of CCR have proven sufficient to play a buffer role and the French Government has had to operate its sovereign guarantee only once since 1982. However, the flat-rate surcharge was increased from 9 % to 12 % in 2000 in order to ensure the financial viability of the regime, given changing patterns of risk.

The French home insurance sector ranks first in weighting scheme 3. This result is surprising, as the weakness of incentives for risk prevention is usually highlighted as the main shortage of the French system for insurance of extreme weather events. However, the score is very similar to that of the second best and remains relatively low (0.58 under continuous scoring, compared with 0.80 and 0.70 under the first and second schemes respectively), thus highlighting an overall finding that there is an insufficient linkage with risk reduction overall. Therefore, by being roughly in line with other countries in the risk-reduction aspect but with a higher performance on the other outcomes, the French case is pushed into first place, and not because it is the best practice in terms of risk-reduction incentivisation.

The main source of risk reduction evolves outside the sphere of the policyholder and, to a certain degree, the insurance industry, with mixed effects. This is because (similar to Spain) the focus in not in providing a risk signal per se but in providing insurance as a social good, which limits the strength of potential risk-management incentives. The first avenue is the PPR (Plan de Prevention des Risques), which can mandate certain activities limiting risk to be undertaken in areas exposed to extreme weather events. However, the extent to which these plans can require risk reduction measures is limited (Poussin et al., 2013). A second external mechanism is that a small part of the CatNat premium (12 % of the insurance premium) contributes to the Fonds de Prévention des Risques Naturels Prévisibles (FPRNM, the so-called Barnier Fund). The fund, in principle, finances preventive measures, generally within the scope of voluntary local prevention action plans against flood (Programmes d'Action de Prévention des Inondations, PAPI). The Barnier Fund was, however, criticised for not really financing hard prevention measures (such as resilient infrastructure investments) and for its lack of transparency (the fund was initially designed to finance expropriation but is currently being used for many other purposes).

The problem of moral hazard is inherent in the compulsory extension of cover, which is provided at a flat premium that is not linked to the level of loss prevention, although this is hard to quantify. The main mechanism employed by French insurers is a deductible that changes, based on past flood experiences, from EUR 380 to EUR 3 050 (i.e. the more events within a set period of time the higher the deductible), dependent on the presence of a PPR (Poussin et al., 2013). However, these two processes are restricted and subject to centralised procedures, so in reality these prerogatives are hardly applied. Moreover, these deductibles fall over time if no claimable event has occurred, further limiting their potential effectiveness.

*Spain:* The Spanish system only scores highly under weighting scheme 1 due to this scheme's focus on the penetration rate and the affordability of insurance. The system scores high on the penetration rate for two reasons. The first is that private insurers provide hail and windstorm protection as a standard part of insurance policies, while uninsurable risks (e.g. flooding) are transferred to the CCS for a small fixed surcharge per mile of coverage purchased. Therefore, policies cannot in effect refuse to provide coverage against extreme weather events. However, despite the fact that coverage against extreme events is a compulsory element of insurance policies, there is no legal compulsion to buy a general household insurance policy. The high penetration rate is achieved due to the presence of an overall developed insurance market and the compulsion to buy insurance from mortgage lenders. Moreover, the overall protection provided by the insurance is also high as coverage is provided against a bundle of extreme weather events, rather than having separate polices covering separate risks.

The compulsory bundling of risks also aids in improving the affordability of extreme weather insurance. The compulsory extension and coverage against the range of extreme weather risks creates a large cross subsidy between high- and low-risk policyholders (or within high or low risks). This cross subsidy helps in making coverage against localised extreme weather events (such as flooding) insurable at low cost. However, it may only be viable when combined with mandated purchases.

Less important, though still significant under the first weighted scheme, the Spanish market also scores highly on the ability to absorb large losses by the development of its own equalisation fund through retained premiums from previous years. Moreover, the CCS also has the potential to buy private reinsurance coverage if deemed necessary, as well as having access to a state grantee for its losses that exceed its ability to pay (though this has not been called upon yet).

The Spanish approach in providing insurance matches the average score in terms of providing quick and certain compensation. The CCS does not require a disaster to be formally declared and is obliged to follow the terms of the original insurance contract or conditions and regulations laid down in law. Therefore, policyholders have certainty regarding whether they will or will not receive compensation. Moreover, the CCS manages the process of receiving claims, loss adjustment and indemnity payments, resulting, in principle, in a smooth payout process with a target of paying out 90 % of claims within 60 days.

Therefore, it can be seen that the Spanish case is successful in providing insurance as a social good, because of its 'compulsory' nature creating a large pool of policyholders that can cross-subsidise high and low risks due to the comprehensive coverage provided by the policy. The insured (nor insurers, effectively) do not have a choice over which disasters to be insured against, allowing systemic localised risks to become insurable as adverse selection pressures are removed. Such an approach allows events that would otherwise be uninsurable to become insurable, given the risk management incentive. However, it is at the expense of removing the risk-signalling role of insurance and imposes a burden on households who are not exposed to these highly localised disasters. Adverse selection could also be solved by mandating insurance coverage, without premium subsidies.

The Spanish approach to household insurance only scores second place under scheme 1. The Spanish approach did not score as highly under weighting schemes 2 and 3. This is because compared to weighting scheme 1, greater importance is placed on sending a risk-reduction signal. This can be clearly seen in that the MCA score drops by 41 % from scheme 1 to scheme 3. The CCS does not provide direct signals for risk reduction due to the consideration that risk reduction is the role of the state and not the insurer per se, whose role is to provide affordable insurance. Therefore, when risk reduction is considered the Spanish scheme appears to be less successful.

*UK:* The UK scores result in it being identified as a best practice on weighting schemes 2 and 3. The UK results are driven by its high overall penetration rate, and above-average attempts of risk management. However, it must be noted that there is still room for improvement as the MCA scores range between 0.58 (weighting scheme 3) to 0.76 (weighting scheme 1).

The UK has a long-developed insurance market where comprehensive insurance is required by mortgage providers. In the UK, insurance is provided by private insurers, whereby the full range of extreme weather events was included in homeowner's insurance policies as a standard feature. The UK insurance industry and government have struck several agreements, starting with the gentlemen's agreement, which led to the statement of principles whereby flooding was included as a standard part of household insurance policies if the area had a 1/75 annual chance of flooding or smaller (in effect it was bundled with other extreme weather risks). Therefore, many homeowners in effect find it compulsory to buy complete coverage against disasters even if neither insurers nor homeowners were legally required to buy or provide it. However, these agreements between the insurance industry and the government were conditional on the continued development and protection of flood protection infrastructure. The rapid succession of major flood events and the perceived underinvestment in protection infrastructure led to rapid changes in premiums and deductibles. This rapid change could have led to flood insurance becoming a non-viable commodity in very high-risk areas. To this end, the insurance industry in collaboration with the government created Flood Re. Flood Re formally cross-subsidises high and low flood-risk households in order to cap flood risk premiums in very high risk areas (about 2 % of households) along with the deductibles that can be charged. Flood Re therefore has a strong focus on availability and affordability rather than risk reduction. Without this development the UK would have scored less well regarding the affordability, availability and the penetration rate of extreme weather insurance. Flood Re is also able to absorb large losses through its pool-like structure: the ability to buy private reinsurance coverage as well as the ability to establish a second levy on insurers to make up for shortfalls in resources. This last feature is an ability that could be considered as a tax-like ability, which required parliamentary approval and state aid approval. This process required an intense period of negotiation between the insurance industry and the UK Government. This highlights a potential problem in introducing similar structures due to pre-existing state aid and competition laws: even though there are possible legal exceptions for natural disasters, it may be legally difficult to replicate.

The Flood Re structure represents a suitable structure for providing affordable insurance by using a formal and transparent subsidy to cap the flood insurance premiums. The current cap on premiums is based on a property tax that takes into account either the ability of a household to pay or fine changes in risk. This could be improved by connecting the premium cap instead to income or sub-classification of the high-risk zone so that an element of risk differentiation is maintained (as argued in Hudson et al., 2017c).

The second important outcome under these two weighting schemes is the ability of an insurance market to signal risk. The UK market scores highly on this indicator due to its overall employment of risk-based pricing (outside of those properties ceded to Flood Re), the standard presence of deductibles and the presence of awareness initiatives led by the Association of British Insurers (among others). Flood Re doesn't focus on risk reduction directly; only on affordable risk transfer. An attempt to manage future risk is that buildings in high-risk zones constructed after 2009 will not be able to be transferred into the Flood Re pool. Therefore, it is hoped that construction in high-risk areas will be limited; however, it is too early to tell if this will be successful or not. A further consideration is that commercial properties are included in the pool. Flood Re is only a temporary structure that aids in improving the affordability and availability of flood insurance. Five-year reviews are planned to monitor the progress that can be made towards fully risk-based premiums over the programme's expected 25-year lifespan. Additionally, Flood Re aims to produce a plan to strengthen its risk management role, which is to be published within a year. Given the problems that occurred to spur the creation of Flood Re, unless either the insurance industry or the state provide a greater focus on risk mitigation or prevention, the same problem may occur (or be larger due to a projected increase in risk).

*Low-performing countries:* The low-performing cases highlight the features of the previously discussed cases. These countries tend to rely on the voluntary purchase of extreme weather insurance, or that the enforcement of purchase requirements is lax to the point where the decision to be insured is effectively voluntary. Moreover, when combined with low awareness levels of the benefits of insurance or the peril of extreme weather events, a low penetration rate is produced. The low awareness can be further compounded by the presence of ad-hoc government compensation, which further lowers the benefits of being insured, relative to not being insured.

An additional common point is that insurers tend to be reliant on their own capital reserves or private reinsurance, which can be suitable for meeting regulatory requirements (such as Solvency II requirements) or more common place events, but they can prove insufficient if very large and widespread disasters occur (as is commonly argued to be a problem with flood insurance in the Netherlands, for example).

***Table 5.3: Summary of features leading to high or low performances in the household sector***

| High performing | Low performing |
|---|---|
| Multiple extreme weather risks are combined in a single policy | Extreme weather risks are separately insured |
| The purchase of extreme weather insurance is connected to a far more commonly required and enforced product (e.g. mortgage contracts, fire insurance) | Lax enforcements of requirements to buy insurance |
| Collaboration between public and private sectors with a commonly stated and understood objective<br><br>This can be seen as a contract between the insurance sector and the government, whereby each group takes actions that maintain the provision of insurance coverage. | Low overall insurance coverage |
| Provision of a national pool or public reinsurance / support for catastrophic losses | Consumers are reliant on direct public compensation for extreme weather event losses |

### ***5.2.2 Agriculture***

*Austria:* The Austrian crop insurance sector scores in either first or second position in each weighting scheme. Due to its high overall performance (i.e. providing compensation 4 days after a loss has been settled for a target total duration of 2 weeks) on most of the individual criterion points that are above the case study average, the dominant provider of crop insurance in Austria is the Austrian Hail Insurance Company, which is a mutual insurance company that aims to provide a broad risk management framework for the agricultural sector. The mutual structure provides a non-profit maximising focus that supports the objective as providing the best risk management infrastructure for the agricultural sector. Moreover, the Austrian Government collaborates with insurers to control and distribute EU subsidies. This allows the insurers to receive data on several factors (i.e. area, type of crops, yields) to develop more suitable insurance products. Government contributions (i.e. premium subsidies) are provided to stimulate farmers to adopt risk management strategies.

The most impressive element of crop insurance in Austria is the level of protection. The Austrian insurance market provides possibly the most extensive form of coverage against extreme weather events as about 60 % of cultivated land has multi-peril insurance coverage (while 80 % is protected against hail). However, it must be noted that the coverage provided in the multi-peril policy differs across perils. Hail coverage matches the insured value (with an 8 % deductible) while the other risks are provided at EUR 175 per hectare (droughts must cause a yield less than 50 % of the long run average per field to trigger compensation). This is a high penetration rate for a market where insurance purchase is voluntary; the only market with a similarly comprehensive degree of coverage is the compulsory pillar of the Hungarian agriculture risk-management system. The Austrian crop insurance market has likely achieved such a high penetration rate because the dominant provider of crop insurance has a long history of providing multi-peril crop insurance (since 1995, longer than many other countries) that promotes great familiarity with the product and its related benefits. Moreover, the mutual structure and the relatively small differences between insurance against only hail vs. multi-peril risks can strengthen the attractiveness of more comprehensive insurance coverage. Moreover, farmers must insure all arable land in order to gain coverage rather than specific fields. This feature provides a mechanism that both increases the percentage of land covered by insurance and addresses adverse selection as farmers cannot only insure specific high-risk parcels (this has been in place since 1987). This blanket insurance coverage can be seen as the foundation of introducing the multi-peril insurance policies, in addition to the government policy that ad hoc government compensation can only be provided if an extreme weather event was not covered by the multi-peril insurance product.

Austria is placed in second place under the third weighting scheme, even though the market's attempts at promoting risk reduction are roughly average. Austria is awarded this place due to the market's higher performance on the other factors, which results in a high overall performance. One main mechanism is the bonus-malus system, which rewards policyholders with a bonus of 30 % if there is no damage and a loss ratio below 0.75 (there is no direct malus element). However, the Austrian Hail Insurance Company also offers early warning mechanisms for thunderstorms (via SMS) or hail (via an app) that can allow the insured to change to employing temporary risk management strategies in advance of an extreme weather event. In addition to general climate change awareness, the company sponsors awards for climate change journalism, scientific programmes and general attempts at lowering climate impacts.

*France:* France reaches second position in the first scheme, meaning that it provides relatively good coverage (in terms of risks covered in principle) and affordable insurance products relative to the other countries. Crop insurance is not mandatory in France and the penetration rate is about 30 % of land and farms (similar to Spain) (FFA, 2016; L'Argus de l'Assurance, 2015). This, according to stakeholders, remains largely insufficient in a context of increasing climate hazards, but is a relatively satisfactory outcome compared with other case study countries. However, as is common, farms are mostly insured against hail, with other weather extremes lacking coverage. The main driving force behind the high score is the ability of France overall to support the compensation of high losses and the overall speed at which insurers provide compensation.

The French system relies on private insurance complemented by a solidarity fund called fonds national de gestion des risques en agriculture (FNGRA). The fund is financed through additional contributions to insurance premiums and a state contribution. In order to receive compensation from FNGRA a farmer must possess (at least) a fire insurance policy.

FNGRA is the main instrument to ensure a minimum level of protection for all farmers. The fund serves three purposes. The first section of the fund contributes to the financing of compensation for economic losses related to the occurrence of an outbreak of an animal or plant disease or an environmental incident by mutual funds approved by the administrative authority. The second section of the fund contributes to the financing of aid for the development of insurance against damage to farms. To this purpose, the fund subsidises a share of the insurance premiums for certain agricultural risks. In principle, subsidies are paid on a flat-rate basis though they can vary according to the magnitude of the risk and the type of production. To be eligible for subsidy, the insurance cover should include drought, hail, frost and flood. In an attempt to boost the insurance market for crops and increase the penetration rate, the French Government has recently increased subsidies to up to 65 % of the insurance premium, i.e. the maximum authorised by the Common Agricultural Policy (CAP) (Enjolras and Santeramo, 2016). The subsidy now takes the form of a reduced premium on the so-called Contrat socle d'assurance récolte, a multi-risk insurance policy for the agricultural sector. Since 2016, the Contrat socle covers losses on production costs rather than losses on turnover only, allowing for quicker and more certain compensation. The subsidy is partly financed by the CAP and partly financed by FNGRA.

The third section of the fund contributes to the compensation of so-called agricultural calamities and is used for unharvested crops and for crops not insured or not excluded from the fund. Agricultural calamities are damages that result from risks other than those considered insurable. Of exceptional importance are the agricultural calamities caused by abnormal variations in the intensity of a natural climatic agent (drought, flood, frost, etc.), which are recognised by ministerial decree. In this scheme, compensations for natural disasters have to satisfy two conditions: an agricultural calamity must be recognised by a decree from the ministry of agriculture and the farm business affected must be covered by an insurance policy (e.g. fire, crop or livestock insurance). The list of insurable risks (events and crops), and therefore excluded from FNGRA compensation, is set by the inter-ministerial decree of 29 December 2010. Insurable risks include hail, as well as all climatic risks to cereals, oilseeds, protein crops, industrial plants, including the seeds of these crops, and on vines.

*Spain:* The Spanish approach to crop insurance is based around the entity known Agroseguro. Agroseguro is a management entity that handles the entire insurance process from issuing claims to loss adjustment, with a self-stated objective to manage agricultural risk as a whole. Agroseguro is a co-insurance pool that manages crop insurance on behalf of its stakeholders (a range of companies involved in providing agricultural insurance). Agroseguro also acts as a body that the Spanish Government can interact with in an efficient manner, rather than interacting with separate insurers. The scores awarded to Agroseguro result in it representing the second best practice on the second weighting scheme and the best practice on the third weighting scheme.

The Spanish insurance market scores the highest score on weighting scheme 3 as the risk reduction element is given a weight four times as large as the other criteria. The Spanish approach scores highest (by between 0.2 and 0.3 points) in terms of its ability to signal risk as Agroseguro employs a range of risk-reduction incentives (e.g. required standards, premium discounts, bonus-malus, information campaigns) that operate at varying scales. Moreover, the Spanish case provided the highest absolute score of all the agricultural cases under this weighting scheme. This mixture of mechanisms can be quite effective in helping to promote policyholder-level risk management. In this sense Agroseguro represents best practice in this regard as four direct risk-reduction strategies interact with one another. First, to be insured a farmer must meet certain pre-set conditions regarding their vulnerability to extreme events, setting vulnerability to an acceptable level. The second is the possibility of receiving a premium discount in return for employing risk-reduction measures, e.g. hail nets, which reduce a farmer's vulnerability past the acceptable base level. This feature is an important addition as it allows Agroseguro to signal measures known to be effective and to allow farmers the option to employ risk-reduction measures in a manner that is cost effective for a particular farmer. The third mechanism is a bonus-malus system. The bonus-malus system results in lower premiums if claims have not been made within a certain period. In this sense farmers can be rewarded for undertaking measures or farming strategies that result in a lower long-run vulnerability to extreme weather events. This mechanism is useful as it allows for a certain degree of information asymmetry between Agroseguro and the policyholder, in that Agroseguro cannot observe and evaluate all the actions that a farmer may take but it can monitor claims as a proxy measurement. However, as noted in Chapter 4, the time frame over which the bonus-malus payments are considered is important as better extreme weather management strategies will only be noticeable in the long rather than short run. Therefore, while it can help to provide risk-management incentives, it can be less effective compared to the other mechanisms.

The Spanish system scores second best on weighting scheme 2, as there is a slight focus upon both the penetration rate and risk-reduction incentives. This slight focus on risk-reduction incentives slightly increased the score (as can be seen in the increase of the MCA score from 0.61 to 0.64). The percentage of cropland insured is in line with the average score awarded; however, the coverage provided is quite extensive. This is because it is provided as yield insurance that protects against the range of extreme weather events studied. Moreover, farmers must insure all land for the specific crop insured. The Spanish approach also scores above average in terms of the ability to absorb large losses due to its pool structure along with access to both private and public reinsurance. Additionally, in the case of truly exceptional losses, farmers with an insurance policy are eligible to receive assistance from the government while uninsured farmers cannot. The remaining scores are roughly average. Therefore, we see that the main reason why Spain provides the second best score is because of the risk-reduction incentives and the comprehensive nature of coverage provided.

The Spanish system provides two sources of inspiration regarding reforms for crop insurance markets across Europe. The first is that a public-private partnership can be centred on a management entity that provides a fixed locus for the relevant stakeholders to engage with when required. A single representative agent can minimise the transaction costs in developing a suitable adaptation policy. Moreover, by providing Agroseguro with the responsibility for policy insurance or claims processing, those involved have an interest in enabling the success of the body. Arguably, Flood Re represents a similar type of body (though there are differences). Flood Re is a not-for-profit insurer owned by the insurance industry and has a formal legislative stance, indicating that similar structures may be possible to replicate in other countries or sectors.

The Spanish approach fails to score the first or second position on weighting scheme 1 due to the low overall penetration rate compared to Austria or Sweden (though this is mainly covering hail). Moreover, the premiums charged are slightly higher due to their comprehensive nature, while the premiums are about 50 % subsidised. While, this high subsidy can limit the degree to which the final price reflects risk, it can help to overcome the relatively high premiums rates (for instance, agricultural rates are whole percentage points of the insured value, while for households the premium rates are fractions of a percentage point of the insured value).

*Sweden:* The insurance of crops in Sweden has been ranked second best together with France on Scheme 1, based on its penetration rate as well as affordability and to a lesser extent availability. However, the main driver is the very high penetration rate. Private hail damage and reseeding insurance is the only crop insurance available, which about 60 % of Swedish crops are covered by. Even though only two perils are actively insured against it still represents a broader degree of protection than several other countries where hail is the main insured extreme weather event. Moreover, the Swedish insurance market is dominated by two firms (one with a ~75 % market share, and the other with ~15 %) so there is a focus on providing insurance that leads to a relative absence in risk-management incentives for crop risk management.

The main driving force behind the high penetration rate can be argued to be the historical system of compulsory crop insurance, which existed until 1994 and was provided by the state. Similarly, countries such as Bulgaria and Romania also had previous state monopoly providers, achieving similar penetration rates, even after the state monopoly and compulsion was ended. However, this approach was removed as part of the requirements of the European Common Agricultural Policy. Furthermore, this approach was problematic in the sense that the rules for compensation were unclear, leaving it too expensive and difficult to determine who should be covered by the payouts. However, despite this it did create a tradition of being insured and a general awareness of the benefits of being insured among farmers, which leads to the high coverage rate.

*Low-performing countries:* Unlike the household sector, the importance of mandating insurance purchase (formally or informally) is not as strongly noticeable with regards to the crop insurance sector. Rather the main concern is the presence of multi-risk insurance policies or named peril only. The countries that ranked as low performing tended to only have coverage being offered for hail-induced losses, leaving other events unprotected. Moreover, the low penetration rate can exacerbate problems with adverse selection and transaction costs (loss adjustment is conducted at the field level) as only the land at highest risk will tend to be insured. Therefore there may be an effective minimum penetration rate, which may act as a threshold for when insurance can become more widespread.

***Table 5.4: Summary of features leading to high or low performances in the agriculture sector***

| High performing | Low performing |
|---|---|
| The use of multi-risk insurance (with a focus on yield insurance) | Only specific weather event insurance products are available |
| Requirements to insure all cultivated land | Only land with a specific crop must be insured |
| Premium subsidies to direct investment in multi-risk policies | Presence of ad-hoc government compensation untied to insurance coverage in the case of truly extreme events |
| Pool-like structures or public reinsurance for systemic risks, such as droughts | |
| Tradition of collaboration between the public and private sector risk managers | |

## 5.3 Outcome of the MCA: overall conclusions – an absence of risk reduction

The scores in the previous table highlight the features of the top performing countries per sector in terms of systematic behaviour. This provides an indication of general features of a market that can be considered to be best practice (overall). However, looking at the scores can also highlight areas to focus upon.

***Table 5.5: Average MCA scores across the 12 case study countries***

| | Private property | Agriculture |
|---|---|---|
| **Weighting scheme 1** | 0.56 (0.19) | 0.58 (0.17) |
| **Weighting scheme 2** | 0.5 (0.15) | 0.5 (0.14) |
| **Weighting scheme 3** | 0.4 (0.13) | 0.41 (0.13) |

*Notes: Values outside parenthesis are mean values (from the continuous ranking scheme); those within parenthesis are standard deviations (from the continuous ranking scheme).*

Scheme 1 focuses on the penetration rate and affordability, while scheme 3 focuses on risk signalling (with scheme 2 acting as an intermediate weighting). The average score across the 12 countries (for both sectors) is highest for scheme 1 and lowest under scheme 3. Moreover, as we move from scheme 1 to scheme 3 we see that the standard deviation falls, indicating a smaller difference in overall outcomes across countries.

This indicates that on the whole (across extreme weather events) the case studies are relatively successful at providing insurance at affordable rates, despite individual deviations from this. Regardless of the relatively good performance, there is still room for improvement. In the household sector, the two main problems to overcome are insuring localised disasters, such as flooding, and promoting households to buy insurance (the two may be interconnected). These two aspects of insurance are responsible on the whole for falls in the household insurance penetration rate, as households either do not fully acknowledge the benefits of being insured or it becomes very expensive to insure, compared to what the household is willing to pay for insurance. The average score under the solidarity and coverage weighting appears to be slightly higher in the agricultural sector compared to the household sector. However, it should be kept in mind that the average penetration rate as a value tends to be lower (an average of 40 %, compared to the 60 % in the household sector).

The case studies on the whole score low on incentives for risk reduction or risk signalling. This comes from the overall reliance on deductibles or awareness campaigns. These incentives provide indirect risk management signals. Awareness campaigns aim to readjust risk perceptions and increase the perceived benefits of risk management. However, unless there are constant campaigns, views are likely to revert after the campaign is concluded. Germany provides an example of where continuous awareness campaigns and the development of different tools have led to a sustained increase in the overall penetration rate of extreme weather insurance. Deductibles by themselves are also unlikely to incentivise risk reduction (*ex-ante*) as unless an extreme weather event occurs the deductible doesn't provide a tangible incentive for the policyholder to act upon.

There are several reasons for why this relative lack of focus on risk reduction has occurred. The first corresponds to the market's focus. A focus on providing widespread or affordable coverage can reduce the focus on risk reduction (i.e. France, Spain). A second barrier is the combination of the indemnity principle (i.e. the insured is compensated for what is lost) and competition between insurers. This can limit the extent to which insurers offer incentives or requirements for risk reduction as customers could instead take a policy with less onerous demands (this was noted to be the case in Bulgaria). A third reason is that there could be informational asymmetries or transaction costs that make offering tangible incentives (such as premium discounts) for a wide range of potential risk-reduction measures unattractive. The costs of setting up and monitoring the employment of such measures could be expensive, limiting the overall benefit. A final barrier can be seen as the lack of transparency in insurance premiums. It is quite common for insurance to be provided as a bundle of risks, making it difficult for a policyholder to identify what part of the premium is for what risk and the degree to which their risk has been shared across the insured population.

Deductibles and awareness campaigns are mechanisms that allow insurers to overcome some of these barriers as it places the primary responsibility on the policyholder to manage their risk and are easily integrated into pre-existing insurance structures.

Policy suggestions to overcome these barriers can come in many forms. A stakeholder focus group highlighted several policy strategies to overcome such barriers. One is the improved use of insurer knowledge in developing zoning requirements, as insurer knowledge of which measures lower risk as part of general building codes. Moreover, such measures would be structural, which may limit information asymmetries, as once employed a policyholder is less likely to stop employing the risk-reduction measure.

The second is to reconsider limitations whereby insurers must return a policyholder to the state they were in before the event and no better off. Introducing 'build back better' requirements could allow the recovery and repair process to build risk-reduction measures directly into buildings when awareness of the impacts of extreme weather events is strongest. In addition, building and construction codes should be applied and followed for new infrastructure (to be potentially incentivised as a condition for EU funding, for example).

A third could be to place the responsibility for risk reduction in the hands of an external body dedicated to promoting and developing risk-reduction strategies, which can collaborate with insurers. The exact nature of such an external body is difficult to determine *a priori* across countries; however, such an organisation can operate directly or indirectly at various national levels (i.e. national, regional or city level). For instance, a national body can produce investments in prevention strategies or larger scale risk-reduction strategies. These actions could facilitate a national minimum level of risk management and insurance viability, upon which more localised bodies or agents can act upon. For example, a city can collaborate with insurers to better manage their risk past this minimum level imposed by the external bodies. It is difficult to determine or propose such structures as the different Member States have varying levels of autonomy for cities or regions. This could be achieved by adding a surcharge to insurance premiums into a fund(s) so that the money raised can be used to construct protection measures, general adaptation measures (e.g. water retention areas), or to subsidise more individual-level measures. This fund can be a management entity whereby insurers, government agencies, etc. are involved in a not-for-profit manner. Moreover, such a management entity could be easier to mainstream into a country's overall climate change adaptation strategy.

***Table 5.6: MCA scores following the continuous ranking system***

| | Household | | | Agricultural | | |
|---|---|---|---|---|---|---|
| | **Scheme 1: Solidarity and coverage** | **Scheme 2: Private good/ PPP working together** | **Scheme 3: Adaptation signal / risk incentive** | **Scheme 1: Solidarity and coverage** | **Scheme 2: Private good/ PPP working together** | **Scheme 3: Adaptation signal / risk incentive** |
| **Bulgaria** | 0.22 | 0.25 | 0.24 | 0.41 | 0.4 | 0.37 |
| **Romania** | 0.38 | 0.35 | 0.23 | 0.5 | 0.43 | 0.35 |
| **Hungary** | 0.56 | 0.45 | 0.32 | 0.63 | 0.54 | 0.45 |
| **Poland** | 0.66 | 0.56 | 0.43 | 0.52 | 0.44 | 0.32 |
| **Demark** | 0.51 | 0.54 | 0.5 | 0.72 | 0.56 | 0.38 |
| **Sweden** | 0.39 | 0.33 | 0.26 | 0.78 | 0.6 | 0.41 |
| **France** | 0.81 | 0.71 | 0.59 | 0.7 | 0.59 | 0.45 |
| **UK** | 0.76 | 0.69 | 0.58 | 0.22 | 0.2 | 0.17 |
| **Germany** | 0.56 | 0.53 | 0.54 | 0.72 | 0.63 | 0.5 |
| **Austria** | 0.74 | 0.56 | 0.38 | 0.81 | 0.68 | 0.53 |
| **Spain** | 0.78 | 0.68 | 0.46 | 0.61 | 0.64 | 0.7 |
| **Italy** | 0.34 | 0.33 | 0.29 | 0.52 | 0.51 | 0.38 |

*Notes: Yellow represents first best, orange represents second best; values are rounded to two decimal places.*

***Table 5.7: MCA scores following the relative ranking system***

| | Household | | | Agricultural | | |
|---|---|---|---|---|---|---|
| | **Scheme 1: Solidarity and coverage** | **Scheme 2: Private good/ PPP working together** | **Scheme 3: Adaptation signal / risk incentive** | **Scheme 1: Solidarity and coverage** | **Scheme 2: Private good/ PPP working together** | **Scheme 3: Adaptation signal / risk incentive** |
| **Bulgaria** | 0 | 0.07 | 0.17 | 0.33 | 0.35 | 0.33 |
| **Romania** | 0.27 | 0.28 | 0.18 | 0.5 | 0.41 | 0.32 |
| **Hungary** | 0.41 | 0.31 | 0.24 | 0.59 | 0.52 | 0.42 |
| **Poland** | 0.68 | 0.59 | 0.49 | 0.45 | 0.39 | 0.25 |
| **Demark** | 0.62 | 0.67 | 0.68 | 0.68 | 0.51 | 0.31 |
| **Sweden** | 0.38 | 0.26 | 0.23 | 0.8 | 0.6 | 0.38 |
| **France** | 0.82 | 0.72 | 0.68 | 0.79 | 0.66 | 0.48 |
| **UK** | 0.79 | 0.76 | 0.72 | 0.04 | 0.05 | 0.03 |
| **Germany** | 0.38 | 0.38 | 0.58 | 0.66 | 0.62 | 0.49 |
| **Austria** | 0.73 | 0.49 | 0.36 | 0.84 | 0.71 | 0.55 |
| **Spain** | 0.77 | 0.7 | 0.5 | 0.63 | 0.71 | 0.81 |
| **Italy** | 0.26 | 0.24 | 0.28 | 0.53 | 0.51 | 0.38 |

*Notes: Yellow represents first best, orange represents second best; values are rounded to two decimal places.*

# 6. THE NEXT STEPS IN INSURING WEATHER AND CLIMATE-RELATED EXTREME EVENTS

The purpose of this chapter is to identify the next steps in insuring weather and climate-related extreme events. To this purpose, the chapter outlines the results from the MCA, together with findings from the stakeholder consultation process, and in line with this, provides general recommendations for steps forward within the subject of insurance and weather-related disasters.

The recommendations presented in this section should not all be specifically implemented by the European Commission but can be seen as a framework that can be used as a starting point for discussion at national level. They can be applied in other cases as we state the general principle of the policy recommendation and leave the general implication of the reform to be decided upon by the relevant stakeholders. This is because the different countries of the European Union operate within different legal and cultural contexts. Therefore while their final approaches may be similar, they are unlikely to be exactly the same to account for these differences.

The chapter begins with recommendations based on the outcomes of the MCA (section 6.1), then additional recommendations based on findings from the stakeholder consultation process are made (section 6.2). These are then combined in the consistent set of recommendations around five policy themes (section 6.3). Specific recommendations to the European Commission follow in Chapter 7.

## *6.1 Outcomes from the MCA and policy recommendations*

This section presents the policy implications and recommendations that are directly derived from the MCA presented above.

A point to keep in mind when considering these outcomes is the relative importance of flood risks compared to windstorm or hail risks. The inventory of insurance markets across Europe identified relatively few problems with the insurance of windstorms or hail because of their widespread nature allowing them to be more easily pooled by the insurance sector (even if demand was low, i.e. in crop insurance). Flooding (of the various types) represents a different problem, which many of the insurance markets have struggled at various points to provide or maintain 'high' scoring outcomes.

### *6.1.1 Private property sector*

**Policy recommendation 1a: Promote the bundling of a complete extreme weather event insurance package with private property fire insurance policies (or a similarly and more often purchased product).**

**Policy recommendation 1b: Urge banks to require full and comprehensive insurance coverage when providing mortgage loans.**

The high penetration rates and coverage levels are provided when a market has an effective compulsion to buy insurance. In such a market, policyholders are obliged to buy coverage against a complete bundle of extreme weather risks. This can be illustrated by the high penetration rate in France compared to the low penetration rate in Bulgaria. Moreover, simply mandating the purchase of extreme weather insurance may not be sufficient to achieve a high penetration rate. Romanian flood insurance represents an example of this situation as it mandates the purchase of insurance though achieves a penetration rate of approximately 20 %, due to its lax enforcement.

The connection of extreme weather insurance to general private property insurance or fire insurance in areas with developed insurance markets can lead to a high average insurance penetration rate as it is tied to a product with a larger perceived value. Moreover, in order to support a high market penetration rate, current government programmes or desires to provide ad-hoc compensation after a disaster should either be stopped or be formalised so that there are very clear rules that imply insurance demand is not reduced. Alternatively, compensation should be provided in loans or potential beneficiaries should pay a contribution towards the fund. The second common feature of the markets that leads to widespread and affordable coverage is the bundling of major risks into a single policy. This reduces the presence of adverse selection and spreads localised risks over a wider area so that premiums become more affordable. Therefore it appears that a policy direction is to remove the choice of (potential) policyholders over whether to insure which kind or perils. Policyholders can be left with the choice of to what degree to insure in order to allow deductibles and coverage limits to match the risk preferences and financial capacities of policyholders. Offering a comprehensive package of extreme weather events is desirable (i.e. not separating wind/hail from floods or landslides, for example). This approach could be more successful than relying on measures to increase risk awareness alone as awareness campaigns will have to be constant and widespread in order to maintain high levels of risk awareness. Nevertheless, such campaigns proved to be successful in Germany.

Moreover, high penetration rates were observed in countries with an effective compulsion to buy insurance in order to protect a bank's asset. This helps to explain in part a rapid increase in insurance penetration rates in eastern Europe (especially in Hungary and Poland). Therefore, the banking sector through its loan terms and conditions could also play a role in closing the protection gap. The combination of policy recommendation 1a and 1b can, in effect, create an informal 'compulsion' to buy insurance. This is a different focus to the cases with a current formal compulsion to buy insurance, as in these cases insurance tends to be provided at risk rates that do not act as a risk signal. The informal compulsion can help to sidestep this issue.

Policy recommendations 1a and 1b can achieve higher penetration rates; however, their exact provision (i.e. insurance regulation, through a public-private partnership) will have to be decided upon at national level.

**Policy recommendation 2: Low-income (following local definitions of low income or social hardship) households struggling to afford extreme weather insurance should have this pressure eased with insurance vouchers or tax credits if they buy insurance coverage.**

The scores awarded to each of the markets regarding affordability indicate that no sector scored more than two points on the affordability criterion out of a maximum of four. The premiums also range from between EUR 30 to EUR 320 before considering high-risk areas (in cases where risk-based premiums are used). This indicates that the source of unaffordability originates from the buying power of insurance premiums rather than the value of insurance premiums themselves. For example, the average premium in Bulgaria in 2015 was estimated to be approximately EUR 90 with an unaffordability rate of ~23 %, or Romania with premiums of approximately EUR 30 EUR and an unaffordability rate of 26 %. Therefore, another policy recommendation is the introduction of mechanisms external to the insurance industry to address the problems of unaffordability. Moreover, this would allow insurance premiums to more clearly signal risk, while allowing public support to be more carefully targeted. Examples of such mechanisms could be tax credits or temporary vouchers for low-income households if they are insured (see e.g. Kousky and Kunreuther, 2014). The mechanisms to address unaffordability will have to take into account the possible development of socially vulnerable communities in high-risk areas. However, if the previous policy suggestion of 'compulsory' bundled insurance is employed then the mechanisms to address unaffordability will be spread across the entire population rather than only high-risk areas. Moreover, these measures from outside of insurance allow the risk-management signals provided by insurance to be strengthened. Moreover, such mechanisms may provide governments with a stronger incentive to more actively manage extreme weather risks, as it may be cheaper to lower risk in the long run rather than paying a stream of vouchers to low-income households in high-risk areas.

Vouchers and tax credits are used in policy recommendation 2 as an example of mechanisms that could be employed. However, the exact mechanism, thresholds and provider can be decided upon on a country-by-country basis, even if there is a common principle behind this dialogue.

**Policy recommendation 3a: Direct incentivisation of risk reduction post-insurance purchase is currently not very effective in practice. Therefore, minimum building standards, or build-back-better requirements, differentiated by risk levels, can be required as a standard element of insurance contracts in order to gain coverage (with a focus on measures integrated into the building).**

**Policy recommendation 3b: Use a surcharge on insurance premiums (either newly introduced or redirected current taxes) to directly finance and construct risk-reduction infrastructure or to directly subsidise household-level risk-reduction measures (i.e. retrofitting buildings).**

The majority of the case studies did not score very highly regarding the risk-reduction incentives offered, systematically, in their area. Those that did score high enough to be considered best practice was because of their high performances on other outcomes, in addition to performing above-average on risk reduction. Moreover, engagement with the insurance sector stakeholders reveals that their focus on risk reduction (as organisations) tends to occur at a different level to that studied in the MCA. There is a focus on preventative measures rather than the actions individual policyholders can conduct. This is because, for the most part, an individual policyholder cannot alter the likelihood of an extreme weather event or its magnitude, although he can influence the damage. The actions a single policyholder can undertake to limit risk face informational asymmetries and transaction costs from the perspective of the insurance provider. The process of mandating such incentives on a large scale (as compared to commercial policies) could be problematic given the standardisation of contracts. Risk-based premiums were not commonly employed across the 12 case studies, and there are fewer cases of where risk-based premiums were combined with premium discounts. Developing such a system with risk-based premiums and discounts for risk reduction could contribute to risk management by a non-negligible amount (e.g. Hudson et al., 2016; Hudson et al., 2017c). The employment of one without the other would be less effective. Nevertheless, it may be possible to promote situations where property after an event is built back better or redirect building to lower risk areas in order to limit future (or recurring) risk. This may entail a slight increase in premiums in order to account for both the compensation provided and the overall improvement (depending on the measures that are expected to reduce vulnerability).

Moreover, insurance premiums are a product of a risk calculation. The more frequent events are the higher the premium and so a focus on prevention (outside the scope of individual policyholders) is required to make an insurance product a viable product. Therefore it may be worthwhile to use premiums as an indicator for where investments in prevention are needed. While it can be argued that only risk-level data is needed to guide these investments, presenting the potential impacts of such investments by a reduction in premiums or the burden premiums place on policyholders could be useful. The presentation of the benefits from risk reduction in terms of lower premiums could frame the benefits in a more tangible or familiar way. Additionally, a small surcharge on premiums could be used to finance such protection infrastructure or to directly subsidise household-level risk-reduction measures. Mechanisms like this exist in Switzerland and France. The organisation responsible will need to have the ability to directly finance and construct such measures (or advertise subsidies at a household level) to overcome the hurdles or disincentives for local authorities investing in risk-reduction infrastructures. However, collaboration may still be required so that all of the stakeholders' local knowledge can be used to identify the most productive use of resources.

Indicators of unaffordability can be used to guide investment decisions so that premiums can become more affordable, allowing risk to be better spread and for those at (higher levels of) risk to be better able to cover their risk. This could be seen as an element of risk sharing, whereby those exposed to the extreme weather event still contribute to pre-funding their compensation, and low-risk households who help to prevent such impacts in the first place. This can allow for insurance to act as a sufficiently accurate signal of risk, which stimulates an external response to lower risk.

**Policy recommendation 4a: Introduce a requirement for flood risk management plans, national adaptation strategies and applications for loans or national or EU funds to include insurance mechanisms for managing risk that cannot be (cost-) effectively prevented in order to further mainstream insurance into national adaptation conversations.**

**Policy recommendation 4b: Create a national focal point or authority for developing and maintaining a legal framework through which extreme weather risks can be managed via a combination of risk reduction and/or transfer. The focal point can be a pre-existing or a newly formed body. However, the focal point should consider the views of a range of stakeholders: local and national government risk managers, insurance bodies, policyholders or consumer representatives, to be decided on a country-by-country basis.**

**Policy recommendation 4c: Lay down the roles and responsibilities of all the stakeholders in a national platform, focal point or authority, in a clear and transparent framework. This could be considered as a 'social contract' between the various sectors involved in managing risk. This can help commit the actors to action and to underline their roles and functions for the coordinating authority (see recommendation 4b). Discussions should, amongst others, cover whether data can be shared between stakeholders, especially public bodies receiving loss data from insurance companies, for the planning of infrastructure.**

Another common feature of the four case studies identified as best practice had a degree of successful and active collaboration between the insurance sector stakeholders and the government. For instance, the French insurance industry's contribution to extreme weather risk management is fairly well integrated, addressing risk transfer, disaster risk reduction financing, and data sharing for a better governance. The public and private sectors have a long-standing cooperation, put in place by the French Association for Disaster Risk Reduction (AFPCN), a non-profit organisation founded in 2001 as the successor to the French Committee for the International Decade for Natural Disaster Reduction, and which is supported by government departments. This body aims to bring together the DRR community to promote a coordinated approach. Its activities include stakeholder dialogue, exchange of good practice and research. This Danish case has flood insurance provision being focused though the Storm Council, which is a body that brings stakeholders together and frames their interaction within a single common goal (i.e. provision of storm surge and fluvial flood insurance). Moreover, the Storm Council over recent years has been benefiting from the greater involvement of private sector insurers. Similarly in the UK, the universal provision of flood insurance can be characterised as a series of negotiations between the British Government and the insurance industry, and what the individual roles of the two should be. The exact nature of this relationship has changed over time. While the relationship may be troubled (see the discussions around, and the process of, forming Flood Re), the very nature of this relationship shows that the groups acknowledge each other's role and require each other to take suitable action. This is not always the case in the other case study countries, as the roles and willingness of the public and private sectors to act productively together is not always clearly established. For instance, in Sweden or Hungary insurance does not have an active role in developing or being a part of national adaptation plans. While in countries such as Germany and Austria, the presence of government compensation actively hampers a larger role for the insurance sector in insuring catastrophic extreme weather events. Another potential problem, as highlighted in the case of Bulgaria, is that sometimes the coordination between the responsible institutions is not on the required level. Moreover, there can be frequent changes to the legal framework in the sector, and the lack of effective coherence, consistency and continuation of the responsible structures has negative consequences for disaster risk reduction. This leads to a reduction in the administrative capacity at national, regional and local levels, as well as to a loss of expertise and past experience.

Policy recommendation 4a represents a holistic approach for acknowledging the role that insurance can play in managing risk because insurance is a key adaptation tool for risks that cannot be cost-effectively prevented. Moreover, the inclusion of such thinking in a report can create more openness to reveal and share information across stakeholders.

Policy recommendation 4b as presented can be broadly understood. This is because at its heart it is promoting an organisational body (current or future) that can coordinate stakeholders across various levels of government and the public in order to overcome hurdles that may inhibit proactive action (i.e. federally structured countries may see governments not wishing to be involved in what is considered as a role for another level of government). This can offer a focal point or a national platform in line with the Sendai Framework. The structure and authority can be decided upon at the local level but it should always have the aim of coordinating all stakeholders that have a stake in risk management or insurance provision. For example, in one country it may be decided that the focal point is the ministry of finance (following an OECD recommendation), while another creates a working group with decentralised powers. There are informal examples of such bodies across the world (e.g. MRN in France, the institute for catastrophic loss reduction in Canada), which can be further formalised to promote cooperation and synergies across the stakeholders' actions.

### *6.1.2 Agriculture sector*

**Policy recommendation 5: Redirect premium subsidies towards multi-peril (yield) crop insurance products to provide more extensive coverage. Each extreme weather event can contribute to the overall premium in line with its risk level.**

Currently the majority of the crop insurance products that are both available and commonly bought cover hail damage only. The Spanish and Austrian insurance markets most often score highest and in both of these markets there is a very large presence of multi-risk insurance products compared to other markets. Moreover, in both cases where multi-risk premiums are more expensive, countries also employ premium subsidies of about 50 %. Therefore, one policy recommendation is the expansion of multi-peril yield insurance, as this would offer comprehensive coverage against both annual yield variations in addition to extreme weather events. This could be achieved by redirecting premium subsidies so that they are only available for comprehensive multi-peril yield insurance (as is the case in France). The redirection of premium subsidies would increase the opportunity cost of not buying more comprehensive coverage. Additionally, lowering standard policies to include a clause that says that losses must exceed a loss of at least 30 % would allow the premium subsidy to equal 65 % of the premium, while providing a sufficient deductible to promote risk management among farmers.

**Policy recommendation 6: In order to reduce the presence of adverse selection in crop insurance and only the high risk land being insured, a farmer should be compelled to insure all arable land as part of the terms and conditions of an insurance policy.**

In order to reduce the presence of adverse selection and to increase the amount of land covered by insurance the Austrian example can be used, which requires that all arable land is insured in order to gain insurance coverage, rather than specific fields. The blanket approach was introduced in Austria in 1987 and formed the basis upon which the 1995 multi-peril crop insurance was provided. This trajectory could therefore be applied to other countries to aid the transition to widespread multi-peril crop insurance.

**Policy recommendation 7a: Link the access to wider agricultural sector subsidies (i.e. those relating to the common agricultural policy or those offered at the national level) to the purchase of sufficient insurance protection in order to develop a tradition of being insured.**

A second common characteristic between the Spanish and Austrian approaches is that the majority of insurance coverage is provided for by a single overarching body that has the overall strategic aim of improving agricultural risk-management strategies. In Austria this is done by a mutual insurance company and in Spain by the members of the insurance pool. The benefits of a single organising body can result in easier access to reinsurance or capital in the case of large agricultural disasters or general economies of scale, facilitating the development of risk reduction or management strategies. Moreover, a single body acts as a locus for the relevant stakeholders to converge upon. A single body could help to lower the barriers to mainstreaming risk reduction into overall adaptation planning, as the organisation must take a comprehensive view of risk management in its own sector.

The remaining case studies on the whole tend to be dominated by a few insurance companies offering crop insurance. Therefore, having a single body may not be sufficient; for example, in the UK, the National Farmers Mutual Insurance Company is quite dominant but does not rank first or second. Also Sweden performs second best on some weighting schemes with a very dominant firm providing insurance. These bodies have slightly different focuses regarding agricultural risk management. For instance, the Austrian hail insurance company only offers products managing agricultural output, while the Farmers Mutual Insurance Company in the UK has diluted this focus by expanding into more general insurance products for farmers. This focus on crop risk management is then supported by a tradition of buying insurance. This is the case in Sweden, Romania, Bulgaria where there were long-lasting systems of compulsory insurance, which can create familiarity with the products that best suit a farmer's needs and overall familiarity with the benefits of being insured. The Swedish system of compulsory insurance coverage was removed in part because of CAP regulations and because it was considered too expensive, but it was sufficient to start a tradition of being insured. The same is true for Bulgaria, which has a far higher penetration rate for the agricultural sector when compared to the private property sector, due to the experience with farmers with crop insurance as a measure for commercial protection. Therefore, supporting the development of a non-profit maximising body concerned solely with minimising farmers' financial risks could help facilitate the development of weather risk transfer arrangements. Moreover, this could be complemented with an obligation to insure all of their farmland, and be combined with access to governmental or EU subsidies that are conditional on them buying sufficient insurance coverage. This provides a very tangible opportunity cost for farmers who are not insured, strengthening the incentive for buying insurance. Moreover, by tying the purchase decision to a subsidy outside the insurance market, allows the premiums to still be risk-based and provide an indication of risk and risk-management incentives.

**Policy recommendation 7b: Develop an agricultural risk management association with a focus on protecting farmers against income variations due to crop yields (i.e. supporting multi-risk yield insurances or the employment of risk-reducing measures), within a mutual or non-profit maximising organisation.**

In accordance with policy recommendation 4b, recommendation 7b can also be broadly understood in regards to the form it should take. There are bodies in transnational regions (like the International Association of Agricultural Production Insurers) or national bodies in Spain and Austria that are already in place, which can be used as an example but would have to be adapted to the national conditions. What would be common for the associations is the objective of supporting the take-up of insurance in the agriculture sector and risk-reducing measures. Members would mainly be representatives from the agricultural business (national agriculture organisations, for example), representatives from the insurance industry and representatives from the government.

## *6.2 Additional considerations from the stakeholder consultation*

This section presents additional policy recommendations gathered from the stakeholder consultation in parallel with the research and analysis on the 12 selected case studies and the MCA.

**Policy recommendation 8: Research with the aim of defining and quantifying resilience to support risk awareness and reduction, and a focus on how insurance can enhance the economic resilience.**

Many of the recommendations in this study are based on effective risk-reduction activities and dependant on the stakeholders' consensus. If, for example, premiums are to be lowered as a result of a specific risk-reduction activity then stakeholders need to agree as to what level the increased resilience should be achieved to change the premium. Furthermore, finding a way to define and quantify resilience would provide a strong basis for policy, planning and adaptation decisions at EU level, down to the individual private property level. Although a quantitative measuring of resilience may or may not be possible, it would be an opportunity to create a common language for stakeholders. On a pan-European level, the European Commission has an important role that can create consensus and engage stakeholders in the discussion. Additionally, a study helping to understand and quantify resilience can also investigate and evaluate new measures for risk management and their effectiveness. This investigation can focus on areas that have been neglected in the current research. For example, the impacts to private property insurance are larger than that to crops and as such, risk management methods for property have been thoroughly studied. However, relatively few agricultural risk-management methods have been studied so far and this can be done in a new, wider study.

**Policy recommendation 9: Support the use of farm income insurance by starting pilot initiatives in various Member States.**

By introducing farm income insurance, a farmer would be protected from a fall in income from any source (i.e. storms, droughts, etc.) and the insurance would thus offer him/her a comprehensive package of protection. This type of insurance removes the focus of insurance away from extreme weather risks to a more tangible focus (annual income), which limits the influence of behavioural heuristics regarding extreme weather events. Risk reduction would have to be encouraged by minimum risk management /risk reduction standards to gain coverage (more active/effective risk management allows the farmer to gain higher levels of coverage). Drawbacks of the method is that this could encourage the farmer to expand into less productive/more risky areas but it could be limited to trends in long-term income, thus reducing the incentive to expand into more risky land (paying for income insurance that does not take into account the new land). While there is a well-known example of income insurance in the USA, it is not commonly provided in Europe; therefore both potential customers and insurers are not familiar with the product and may be hesitant to provide it. This could be supported by the EU through subsidies for income insurance or the establishment of an EU-wide reinsurer for agricultural income insurance. However, it is believed that further research is necessary to design and implement such an insurance.

**Policy recommendation 10: Create a working group in the European Commission enabling cross-Directorates-General collaboration as well as coordination with national bodies.**

The area of insurance and weather-related disaster risk reduction is one that affects multiple agencies and Directorates-General (DGs) in the European Commission, and in order to avoid silos and ensure horizontal coordination, the creation of a working group on insurance and climate risk reduction is recommended. The working group should have representatives from the DG for European Civil Protection and Humanitarian Aid Operations (ECHO), the DG for Agriculture and Rural Development (AGRI), the DG for Financial Stability, Financial Services and Capital Markets Union (FISMA) and be led by the DG for Climate Action (CLIMA). It would be responsible for the important role of the European Commission to foster innovation, engage and educate stakeholders, and provide platforms for multi-stakeholder initiatives. This would involve, amongst other things, the coordination of national bodies, communication with external stakeholders and ensure collaboration with initiatives, like for example the Geneva Association, UNEP PSI, ClimateWise, MCII, etc.

**Policy recommendation 11: Recommend that cities assess their vulnerability in regard to insurance penetration rates, including cover for municipal infrastructure and extreme weather events, as well as to report on how they use insurance as a mechanism for managing risks.**

The role of cities and regions has not been addressed in the 12 case studies since they were carried out at national level. However, with the importance of cities and regions in regards to preparing and implementing their climate adaptation strategies in general, further steps need to address their capacity and needs. The national strategies for adaptation, including the insurance mechanisms for managing risks that cannot be (cost-effectively) prevented in the city's adaptation strategy, do not only increase risk awareness, but can also guide investment in adaptation measures (such as investments in damage preventive structures or defining building zones). This would include an assessment of their vulnerability in regards to the penetration rate, including municipal assets.

**Policy recommendation 12a: Promote the use of insurance disaster loss data in the municipalities' risk-assessment data.**

**Policy recommendation 12b: Promote the active and collaborative sharing of risk, hazard and impact data across stakeholders though the standardisation of metadata (to understand what the data contains) and the format (i.e. GIS files) of granular data so that they can be more efficiently and transparently shared across stakeholders productively.**

Using insurance disaster loss data when developing risk maps and prioritising risk zones significantly increases the municipalities' ability to make better climate adaptation decisions. Norway and Denmark have both used insurance data for risk modelling in a number of municipalities in order to better improve their attempts at managing extreme weather events. The financial benefits of using insurance data are currently evaluated in both countries. In Denmark, the insurance companies got more favourable contracts with re-insurance companies since they could prove that the municipalities had significantly reduced risk through the planning and implementation of adaptation strategies.

A major challenge in the use of the insurance loss data are data protection acts and especially the European General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679), adopted in April 2016, which is planned to be enforceable from 25 May 2018. This makes the rules on valid consent in regards to insurance data collected and the purposes data is used for. Furthermore, the General Data Protection Rule puts the 'right to be forgotten' on a statutory footing. This means data processors must, for example, erase personal data when the data is no longer necessary in relation to the purpose for which it was collected or when the data subject withdraws their consent.

In Denmark, the issue of data protection was addressed in such a way that individual households or companies could not be identified. Furthermore, the municipalities were only allowed to hold information for a specific amount of time. In Norway, insurance loss data was combined with other loss data from the municipalities and it was ensured that the data could not be traced back to individual insurance companies. The Norwegian Data Protection Authority could issue an exemption to the law that policyholders/claimants have to agree to the use of data based on two reasons: 1) the data was not sufficiently sensitive to be protected, and 2) the data was essential for the municipality to be able to ensure risk mapping.

The main difficulty in the use of insurance loss data for risk modelling would be to access the data from the insurance industry, as this is one of the assets that they build their business on but this would make them reluctant to release it. An analysis of the cases where this has been done and a communication of these best practices (through, for example Climate ADAPT) could possibly alter this reluctance. Furthermore, such collaboration would require a great deal of trust between the partners. The EU may play a role in regards to creating platforms for stakeholders to meet (as described above). In the cases of both Denmark and Norway, trust between partners has been indicated as one of the key success factors but it should be mentioned that the majority stakeholders in Denmark already had a relationship through the Danish Storm Council. The creation of a national body would be a first step in fostering a strong relationship between stakeholders, which, for example would facilitate collaboration regarding loss data.

This sharing of data is important because there are elements of a public good in the various sources of data regarding extreme weather events (i.e. meteorological data, insurer loss data and scientific hazard maps). The data currently rests in different silos with different levels of access and cost available. The barriers (formal, informal, monetary or otherwise) should be reduced. This is because the wider the data access there is, the greater the 'competition' for the most productive use of the data. This process can add value to the data that a stakeholder may have in ways that they may not see for themselves. Moreover, data produced as part of scientific studies (see recommendation 8) should be made accessible to all interested parties. This is in line with Key Area 1 in the European Commission's Sendai Action Plan, which is to 'promote the collection and sharing of baseline loss and damage data'.

**Policy recommendation 13: Promote the use of community rating systems for premium setting.**

One way to make the relationship between the premium and climate adaptation measures more transparent is community rating systems, which are implemented in the USA. The principle behind the community rating system (CRS) in the National Flood Insurance Program (NFIP) is that communities involved in the NFIP can earn premium discounts for their citizens if they score enough points on a range of criteria: from awareness campaigns to the construction of levees. It is unclear how well the CRS works in lowering risk due to the wide range of activities that can earn premium discounts, but the principle could be applied in Europe, with a stronger focus on activities that directly lower risk, i.e. improved drainage, retention areas, building codes. There would, however, be differing levels of autonomy for local governments or regions across Europe, creating difficulties where cities/regions may not have the official ability to develop risk-reduction measures. Therefore, the level of implementation could not be pan-European but would work on a national level.

**Policy recommendation 14: Promote the spreading of risk by allowing cities to pool their insurance.**

Another potential area that should be further explored is, for example, allowing cities to pool their insurance, which is an effective way to spread risk. With the natural diversification of cities and risks across Europe, cities would create an insurance pool to provide compensation in case of a disaster event in order to aid recovery. With implementation at a pan-European level, the Commission would have a role in creating and sustaining dialogue between cities, Member States and insurance companies. This could, for example, be done through the national bodies that are recommended in the study or through the Covenant of Mayors for climate and energy.

**Policy recommendation 15: Increase capacity building with regards to insurance and climate resilience.**

Capacity building of cities and regions on aspects such as vulnerability assessments and identifying areas where insurance can promote resilience to the use of insurance loss data is a crucial success factor for the above-recommended initiatives. This could, for example, be done through the Covenant of Mayors and/or national bodies (under recommendation 4a above), should they be established. The LIFE Programme for Climate Action can be used to provide financial support for the activities required to build the capacity of Member States, including municipalities. While national bodies can provide an excellent platform for cities to share their experience on national issues and conditions and gain further capacity building within this area, the Covenant of Mayors enables the cities to do so on a pan-European level.

An example of such a project is the LIFE DERRIS project (project ref. LIFE14 CCA/IT/000650), which aims to transfer knowledge from insurance companies to public administrations and SMEs in terms of risk assessment and risk management for catastrophic weather events. Furthermore, it focuses on implementing innovative forms of PPPs for climate catastrophes, involving SMEs, public administration bodies and insurance companies, which is consistent with the EU Adaptation Strategy and the Green Paper on the insurance of natural and man-made disasters.

## *6.3 Overview of policy themes and recommendations*

Recommendations concluded from the study have been grouped into five themes which are: promote risk awareness and reduction; closing the protection gap; the role of public and private entities in the risk cycle; the role of cities and regions; and increase reporting requirements and knowledge sharing. It should however be noted that the recommendations are, in many cases, cross-cutting and can cover several themes.

The policy themes and recommendations foster and/or improve the use of insurance to increase resilience and can be considered as a framework that can be used at the national level to provoke a discussion on how these recommendations can be taken up and adapted to fit local circumstances and preferences. The adjustment of these recommendations to more localised variants can be an important step in providing the stakeholders with a sense of ownership over the reforms, and improving their ability to manage extreme weather risks more generally.

While there are a number of themes and recommendations presented in this study, they only make up a part of the many mechanisms to consider in order to reduce the risk to weather-related events. Additional mechanisms have not been included in the recommendations as they have not been relevant on a pan-European level or concluded from the 12 case studies.

Table 6.1 below provides an overview of the policy themes and recommendations uncovered by the study. The theme is listed with the sector it falls under which are: private property, agriculture, city or Member States. It should be noted that the number of recommendations under each sector does not indicate the importance of the sector.

*Table 6.1: Overview of policy themes and recommendations*

| Sector | Theme and recommendation |
|---|---|
| | **Promote risk awareness and reduction** |
| Private property | 2: Low-income (following local definitions of low income or social hardship) households struggling to afford extreme weather insurance should have this pressure eased with insurance vouchers or tax credits if they buy insurance coverage. |
| | 3a: Minimum building standards, or build-back-better requirements, differentiated by risk levels, can be required as a standard element of insurance contracts in order to gain coverage (with a focus on measures integrated into the building). |
| Multi | 8: Research with the aim of defining and quantifying resilience to support risk awareness and reduction and a focus on how insurance can enhance the economic resilience. |
| | **Closing the protection gap** |
| Private property | 1a: Promote the bundling of a complete extreme weather event insurance package with private property fire insurance policies (or a similar and more often purchased product). |
| | 1b: Urge banks to require full and comprehensive insurance coverage when providing mortgage loans. |
| Agriculture | 5: Redirect premium subsidies towards multi-peril (yield) crop insurance products to provide more extensive coverage. Each extreme weather event can contribute to the overall premium in line with its risk level. |
| | 6: In order to reduce the presence of adverse selection in crop insurance and where only the high-risk land is insured, a farmer should be compelled to insure all arable land as part of the terms and conditions of an insurance policy. |
| | 7a: Combine access to wider agricultural sector subsidies (i.e. those relating to the common agricultural policy or those offered at the national level) to the purchase of sufficient insurance protection in order to develop a tradition of being insured. |
| | 9: Support the use of farm income insurance by starting pilot initiatives in various Member States. |
| | **Support PPPs and cross-organisational collaboration** |
| Private property | 3b: Use a surcharge on insurance premiums (either newly introduced or redirected current taxes) to directly finance and construct risk-reduction infrastructure or to directly subsidise household-level risk-reduction measures |
| | 4b: Create a national focal point or authority for developing and maintaining a legal framework through which extreme weather risks can be managed via a combination of risk reduction and/or transfer. |
| | 4c: Lay down the roles and responsibilities of all the stakeholders in a national platform, focal point or authority, in a clear and transparent framework. |
| Agriculture | 7b: Develop an agricultural risk management association with a focus on protecting farmers against income variations due to crop yields, within a mutual or non-profit maximising organisation. |
| Multi | 10: Create a working group in the European Commission to enable cross-DG collaboration as well as coordination with national bodies. |

| Sector | Theme and recommendation |
|---|---|
| | **Increase the role of cities and regions** |
| Cities and regions | 11: Recommend cities assess their vulnerability in regard to insurance penetration rates, including for municipal infrastructure and extreme weather events covered, as well as to report on how they use insurance as a mechanism for managing risks. |
| Cities and regions | 12a: Promote the use of insurance disaster loss data in the municipalities' risk-assessment data. |
| | 12b: Promote the active and collaborative sharing of risk, hazard and impact data across stakeholders though the standardisation of metadata and the format of granular data so that it can be more efficiently and transparently shared across stakeholders productively. |
| Cities and regions | 13: Promote the use of community rating systems for premium setting. |
| Cities and regions | 14: Promote the spreading of risk by allowing cities to pool their insurance. |
| Cities and regions | 15: Increase capacity building in regards to insurance and climate resilience. |
| | **Integration of resilience, including insurance data, in relevant policies** |
| Member States | 4a: Introduce a requirement for flood risk management plans, national adaptation strategies and applications for loans or national or EU funds to include insurance mechanisms for managing risk that cannot be (cost-) effectively prevented in order to further mainstream insurance into national adaptation conversations. |

# 7. RECOMMENDATIONS TO THE EUROPEAN COMMISSION

While the previous section provides recommendations on steps forward, not all of them are in the European Commission's mandate or interest to execute. Therefore, many of the policy suggestions and themes are to be discussed at national level and adapted thereafter. The overview of Article 196 in the Treaty on the Functioning of the European Union (TFEU) sets forth that the EU shall foremost support and complement Member States actions, and promote cooperation and consistency. This was reflected in the European Parliament's reply to the Green Paper on the insurance of natural and man-made disasters, which rejected the idea of a one-size-fits-all solution to be implemented across Europe and for the EU to intervene on the national insurance markets.

This study therefore recommends that the EU takes the role of facilitating discussions and provides platforms for multi-stakeholder collaboration, promoting the use of insurance to increase resilience to weather-related events and most importantly, increase risk awareness and risk reduction.

This section is based on the general recommendations presented previously but lists the specific recommendations for the European Commission. These recommendations are presented along with comments on their implementation with the following points of focus:

- A justification for the necessity of implementing the suggested change
- Risks and potential mitigation strategies
- Conditions for the implementation
- Principal actors that need to be involved in the implementation
- Timing (short/medium/long-term/ongoing)
- Any potential budget implications

Note that these recommendations are not presented in order of importance; instead, they follow the structure of the policy themes.

### 7.1 Increase reporting requirements and capacity building

| | Recommendation 1 |
|---|---|
| **Recommendation 1** | **Increase the requirements or recommendations for Member States to assess their vulnerability in regard to insurance penetration rates and events covered, as well as to report on how they use insurance as a mechanism for managing risks.**<br><br>Member States should report in their national adaptation strategies on insurance coverage in the country, as well as on how insurance is used as a mechanism to promote climate adaptation.<br><br>Furthermore, and in line with the national adaptation strategies, there would a requirement for cities to also include insurance coverage and/or insurance payment mapping in their adaptation strategies.<br><br>Mandatory reporting under the Flood Directive (2007/60/EC) should take the role of insurance into consideration in the flood risk maps and the flood risk management plans. The flood risk map, which should indicate the potential economic damage, should include information on penetration rates and events covered, while the flood risk management plans should consider the use of insurance mechanisms for managing risks. |
| **Sector** | Member States |
| **Justification** | Action 8 in the EU adaptation strategy promotes the use of products and services by insurance and financial markets. This is subsequently addressed in point 8e on the adaptation preparedness scoreboard which states 'adaptation is mainstreamed in insurance or alternative policy instruments, where relevant, to provide incentives for investments in risk prevention'. By including information on the insurance conditions in the national adaptation strategies, this increases the risk awareness of the Member States, as well as making the European Commission informed on what the insurance status is in the EU.<br><br>The three priorities under the EU adaptation strategy are:<br>1. Promoting action by Member States<br>2. Better informed decision-making<br>3. Key vulnerable sectors.<br><br>By increasing reporting requirements and recommendations, it is believed that all these priorities will be met in regards to using insurance to promote climate adaptation. Member States will be encouraged to act with an increased awareness of their risk and how insurance can be used to manage it. With increased risk awareness, both the Commission and the Member States will be able to make better informed decision-making and be able to approach the sectors or regions that have been identified as vulnerable in the reports. |
| **Risks** | There is a risk that increased reporting requirements could be met with resistance if the benefits of the requirements are not clearly communicated and promoted. |
| **Conditions** | Member States and municipalities should have the capacity to asses vulnerability based on insurance coverage, as well as how to use insurance as a risk management tool. This could be ensured by the capacity building measures, which are introduced in the following recommendations. A roadmap or guidelines provided to Member States or cities through, for example, the Covenant of Mayors or through the Climate-ADAPT website would provide additional support to the preparation of the vulnerability assessments and risk-management |

| | Recommendation 1 |
|---|---|
| | strategies, as well as the implementation of the strategies.<br>A dialogue with the Member States is also important in order to create consensus on the new reporting requirements. |
| **Principal actors and responsibilities** | The actors would include Member States, municipalities, project applicants and the European Commission. It would be the responsibility of the European Commission to impose the new requirements or the recommendations to report on insurance vulnerability and management, and for the other actors mentioned to prepare the reporting. |
| **Budget implication** | The new requirements and recommendations would involve an increase in administrative costs. |
| **Timing** | The second review of flood hazard and risk maps are to be prepared before December 2019, and the second review of the Flood Risk Management Plans is due in December 2021.<br><br>As the EU strategy on adaptation to climate change is currently under review, this poses an opportunity to consider the inclusion of insurance data and information about how insurance is used as a mechanism to manage risk in the national adaptation strategies as well as city adaptation plans. |

| | Recommendation 2 |
|---|---|
| **Recommendation 2** | **Include an *ex-ante* conditionality for the European Structural and Investment Funds on assessing insurance vulnerability and the usage of insurance as a risk management tool.**<br><br>The European Commission's Sendai Action Plan promotes the consideration of disaster resilience and risk prevention and management in the European Structural and Investment (ESI) Funds programmes' implementation. This study recommends that the promotion includes insurance vulnerability and usage in the implementation.<br><br>Furthermore, while climate and disaster proofing is built into the appraisal of major projects for cohesion policy support (through the ESI Funds), the role of insurance should be stressed by requiring that the insurance of the investment is part of the vulnerability and risk assessment, and that the use of insurance is considered in the adaptation planning. |
| **Sector** | Member States |
| **Justification** | Similar to the recommendation given above on adaptation strategies and flood-risk planning, an increase in reporting requirements would support the use of insurance as a risk management tool and also increase the Commission’s awareness on the coverage and usage of insurance as a risk management tool in the EU. |
| **Risks** | There is a risk that increased reporting requirements could be met with reluctance if the benefits of the requirements are not clearly communicated and promoted. |
| **Conditions** | The increased requirements on using insurance as a risk management tool and reporting on it demands an increase in the capacity of the Member States on this. The usage of insurance in the preparation and implementation of projects should therefore be a part of the capacity- |

| | Recommendation 2 |
|---|---|
| | building activities recommended to the Member States. Furthermore, and in line with the recommendation above, information and guidelines should be provided through Climate ADAPT. |
| **Principal actors and responsibilities** | Member States, European Commission, European Investment Bank |
| **Budget implication** | New requirements and recommendations would involve an increase in administrative costs |
| **Timing** | Short to medium term |

## *7.2 Promote risk awareness and reduction*

| | Recommendation 3 |
|---|---|
| **Recommendation 3** | **Fund a study with the aim to define and quantify resilience at EU level with a focus on how insurance can enhance economic resilience.** |
| **Sector** | Multi |
| **Justification** | A project that would aim to define and quantify resilience would possibly create an understanding of which risk-reducing measures are most cost-effective and thereby create stakeholder consensus on, for example, to what degree a specific action should lower premiums. The European Commission has an important role as a neutral arbitrator that can, on a pan-European level, create consensus on risk-reducing measures. |
| **Risks** | This is a highly complex task, both in regards to defining resilience and in creating stakeholder consensus. The results of the study might be limited. |
| **Conditions** | As with many initiatives and projects suggested, a multi-stakeholder approach is required. |
| **Principal actors and responsibilities** | It is the responsibility of the European Commission to fund and manage the project and as a service provider to implement it. The additional actors involved are the stakeholders to be consulted on the projects, which could, for example, be the insurance industry, academia, cities and regions. |
| **Timing of implementation** | The study would be expected to have a 1-year duration and if there are funds available, it could be initiated at rather short notice by the European Commission. However, while the implementation of the study on resilience could be done in a short period of time, the end objective of stakeholder consensus knowledge sharing should be seen from a medium-term perspective. |
| **Budget implication** | The project budget would vary greatly, depending on the scope of the project and the number of sectors to study. A project budget could roughly be estimated at EUR 400 000. |

| | Recommendation 4 |
|---|---|
| **Recommendation 4** | **Promote the use of insurance mechanisms that will support damage prevention to Member States.**<br><br>Promote bundling of a combination of extreme weather events with private property fire insurance policies (or a similar product).<br><br>Inform stakeholders about the potentials of low-income households receiving subsidies for insurance in the form of insurance vouchers or tax credits if they buy insurance coverage.<br><br>Foster discussions in relevant forums about minimum building standards or build-back-better requirements (after events), differentiated by risk levels, which may be required as a standard element of insurance contracts in order to gain better coverage.<br><br>There are a number of channels for information and platforms for discussions that can be used by the European Commission in order to reach the relevant stakeholders. The current study is one of them. Should a focal point for these types of discussions be created or organised in a Member State (unless already existing), this provides an excellent opportunity for a platform in which these types of mechanisms and their potential in the country can be discussed. |
| **Sector** | Private property |
| **Justification** | By informing Member States about the benefits of these measures and discussing how they could be implemented at a national level, the Commission would be able to promote risk awareness and reduction tailored to the national legislations and conditions. |
| **Risks** | The Member States and the private sector might be opposed to interference, as this may reduce their income from taxation, and hamper private business models.<br><br>Should a Member States not realise the benefits of an increased penetration rate, they would most probably be opposed to subsidies for low-income households. |
| **Conditions** | The Commission is merely involved in sharing information and initiating discussions and not in the actual implementation of the insurance mechanisms in the Member States. The condition for this is that the Commission can identify the right channels, forums and platforms in which this can be discussed. By creating a working group in the Commission involving several DGs it is believed that more channels and forums can be accessed and stakeholders reached (this is further discussed below). |
| **Principal actors and responsibilities** | Government bodies, insurance sector, European Commission<br>It is the responsibility of the European Commission to initiate the discussions. |
| **Timing** | The initiation of discussions and knowledge sharing can be done in the short term but the implementation of recommended mechanisms would be done with a long-term perspective, depending on the Member States and the insurance industry. |
| **Budget implication** | The recommended actions to improve awareness of the recommended measures will be approximately cost-neutral as they will be incorporated in ongoing discussions and consulting processes. |

### 7.3 *Closing the protection gap*

| | **Recommendation 5** |
|---|---|
| **Recommendation 5** | **Increase the proportion of funds to the second pillar of the CAP, focused on the risk-management toolkit, including insurance schemes for crops, animals and plants, as well as mutual funds and an income stabilisation tool.**<br><br>At national level, the following conditions should be considered:<br><br>Redirect premium subsidies towards multi-peril (yield) crop insurance products to provide more extensive coverage. Each extreme weather risk can contribute to the overall premium in line with the threat posed by each extreme weather risk.<br><br>In order to reduce the presence of adverse selection in crop insurance a farmer could be compelled to insure all arable land as part of the terms and conditions of an insurance policy.<br><br>Introduce farm income insurance as a potential tool through a pilot project. |
| **Sector** | Agriculture |
| **Justification** | While carefully organising subsidies to not exclude private insurance instruments from the market, the EU has an important role to play in increasing the tradition of being insured in the agriculture sector. Fostering the purchase of insurance should, however, be combined with risk-reduction activities. |
| **Risks** | There would potentially be resistance to moving to subsidised insurance rather than income, and possibly hesitation about changing products to something stakeholders are not familiar with. |
| **Conditions** | Extensive awareness raising and the promotion of the new subsidisation as well as insurance schemes would be a prerequisite for stakeholder engagement and acceptance.<br>The new instruments would call for a strong private and public partnership, which could be initiated in the agricultural risk-management association described in the recommendation below. |
| **Principal actors and responsibilities** | European Commission, DG AGRI, Member States, insurance sector |
| **Timing** | Long term |
| **Budget implication** | There would be no increase in the budget for the CAP as it is a redirection of existing subsidies but there are, however, administration costs in redirecting them. |

### 7.4 *Support PPPs and cross-organisational collaboration*

| | **Recommendation 6** |
|---|---|
| **Recommendation 6** | **Support and facilitate the creation of a national focal point or authority** for developing and maintaining an institutional and legal framework through which extreme weather risks can be managed via a combination of risk reduction and transfer. |

| | Recommendation 6 |
|---|---|
| | **Support and facilitate an agricultural risk management association** with a focus on protecting farmers against income variations due to crop yields (i.e. supporting multi-risk yield insurances or the use of risk-reducing measures), within a mutual or non-profit maximising organisation. |
| **Sector** | Multi |
| **Justification** | By centralising the responsibility for natural disaster risk to a national body in the Member State, there will be a natural platform for the various stakeholders to meet. The role here of the EU as facilitator would be important in order to share information on best practice, bringing together stakeholders and assist with the definitions of roles and responsibilities, as well as ensuring that the momentum is not lost. As can be seen in examples presented in the MCA outcomes, such platforms have from previous experience opened up for additional collaboration initiatives such as joint research actions and a voluntary sharing of data. |
| **Risks** | It is important that members of the body are committed to the initiative and that stakeholders buy in to the initiative as well because the risk-reduction measures would be funded by a surcharge on the insurance premiums. |
| **Conditions** | Clear and transparent discussions of the roles and responsibilities of all the stakeholders should be clearly stated and noted. |
| **Principal actors and responsibilities** | Insurance associations, agricultural associations, insurance companies, responsible ministries, local governments, the European Commission |
| **Timing** | Medium to long term |
| **Budget implication** | The responsibility and costs for the creation of the bodies are covered at national level but there might be a need for the Commission to coordinate and motivate these bodies and therefore a need for a budget to cover an increase in administration costs. |

| | Recommendation 7 |
|---|---|
| **Recommendation 7** | **Create a working group in the European Commission enabling cross-DG collaboration, awareness raising and stakeholder collaboration, as well as coordination with national bodies.**<br><br>The body would have representatives from DG ECHO, DG FISMA, DG CLIMA (lead), DG AGRI, DG Competition (COMP) and other interested DGs, with part of their responsibilities being to document and share good practices, demonstrating socio-economic benefits of prevention and risk-transfer measures and their relationships. They would also coordinate the national bodies and streamline efforts with other relevant stakeholders. |
| **Sector** | Multi |
| **Justification** | Benefits of a working group in the Commission are:<br>• A single entry point for Member States and external stakeholders to the Commission with regard to insurance and weather-related disaster risk reduction. This could ease the coordination with the national bodies/ focal points.<br>• Disaster risk management is a shared responsibility across many DGs, and coordination and harnessing synergies of experience and |

| | Recommendation 7 |
|---|---|
| | expertise is not yet optimal.<br>• The creation of a working group supports the European Commission's strategic priority of a financial instrument to finance public policy.<br>• An increased focus on increasing resilience through various mechanisms, including insurance.<br>• As discussed above, promoted insurance mechanisms or other actions within insurance needs to be discussed with the relevant stakeholders in order to gain consensus. If the Commission can agree on a communication plan and what to promote or discuss, it will be easier to reach the relevant stakeholders as the multiple DGs will access different platforms and forums. |
| **Risks** | There could be difficulties in generating consensus on responsibilities, goals and objectives within the working group, which is a requirement for the benefits described above to be realised. |
| **Conditions** | Document and communicate responsibilities, goals and objectives that have been commonly agreed on in the group. |
| **Principal actors and responsibilities** | The suggested DGs to be involved are DG ECHO, DG FISMA, DG CLIMA and DG AGRI. It is, however, the responsibility of DG CLIMA to take the initiative, form the working group and chair it. |
| **Timing** | Short term |
| **Budget implication** | Although costs for forming and managing the working group are likely to occur in the implementation of this recommendation, the over-arching assumption is that, overall, through the increased streamlining and harnessing of synergies between DGs, there should not be any significant budget implications.<br>The man-days required for coordination with national bodies and other external stakeholders is not seen as a cost falling under the formation of the working group. On the contrary, the formation of a working group and the streamlined practices could lower the administration costs required for coordination with external stakeholders. |

## 7.5 *Increase the role of cities and regions*

| | Recommendation 8 |
|---|---|
| **Recommendation 8** | **Fund projects with the aim of increasing the capacity of cities to use insurance as a risk management tool and insure infrastructure.** |
| **Justification** | It is recommended that the European Commission will in general act as a facilitator and coordinator between stakeholders, which requires national and local authorities to plan and implement policies and projects. This will require a focus on capacity building, which can be financed through, for example, the LIFE Programme. |
| **Sector** | City |
| **Risks** | None |
| **Conditions** | Municipalities buy in to these capacity-building projects. |
| **Principal actors** | European Commission, municipalities, consultants |

| | Recommendation 8 |
|---|---|
| **and responsibilities** | |
| **Timing** | Ongoing |
| **Budget implication** | Substantial funds would be required for capacity building at the start of the initiatives but this is expected to create long-term benefits as the actions suggested in this study are to be taken on a national or regional level. |

| | Recommendation 9 |
|---|---|
| **Recommendation 9** | **Create a dialogue between the insurance industry, municipalities and national bodies on how community rating systems and the pooling of city insurance can be developed.** |
| **Sector** | City |
| **Justification** | By facilitating a discussion between different stakeholders and taking an active role, the European Commission would explore whether these mechanisms would be possible to implement at a national or pan-European level. |
| **Risks** | Local legislation and conditions may hinder the initiatives. |
| **Conditions** | The relevant stakeholders would need to be included in the discussion. |
| **Principal actors and responsibilities** | European Commission, insurance industry, municipalities, Member States |
| **Timing** | Long term |
| **Budget implication** | The budget implications would be limited as the Commission would only be responsible for creating a discussion, which should fall under the other recommendations in this study for increased consultation between the European Commission and other external stakeholders, such as the insurance industry and cities and regions. |

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## APPENDIX 2
## CASE STUDY NARRATIVES AND ATTRIBUTE TABLES

### *Austria*

The opportunities for risk transfer in Austria are divided into two elements: a public mechanism in the form of a catastrophe fund and private insurance, which interact with one another. In Austria, with the exception of storms and hail which are part of standard property insurance (and a voluntary extension for businesses), many extreme weather events are insured on a voluntary basis, that many households in Austria have as a matter of course. However, the Austrian catastrophe fund provides compensation when other extreme weather events occur. This creates a large problem with charity hazard as the catastrophe fund and private insurance compete for coverage of extreme weather events. This can be seen as for major floods ~5% of the loss is compensated via insurance. This creates a potential gap in coverage as noted below the average compensation provided by the fund amounts to only 20-30% of that suffered.

The post-disaster catastrophe fund (Naturkatastrophenfonds) is funded by 1.1% of the federal government's share of income, capital yield and corporate taxes (corresponding to ~7 EUR for private households and ~30 EUR for businesses). The fund can build up a reserve of up to 29 mil EUR. Additional resources can be allocated if special laws are enacted. The budget of the catastrophe fund is allocated to both prevention and compensation. The catastrophe fund spends ~73% of its budget on preventive measures against flooding and avalanches, water quality assessments, warning and alarm systems, grants to the agricultural sector, and costs of preventing water contamination. The reaming (~27%) is used to support the financial compensation paid by the lander to those affected, which corresponds to an average indemnity of about 20%−30% of the damage suffered. Infrastructure can be compensated by up to 50% of the loss. However, there is not a legal right to compensation or a certain level of assistance. However, political motivates can play a role in determining the level of compensation.

Private market insurance coverage against losses resulting from natural hazards is available in Austria since the mid-1950s, in particular with respect to losses occurring due to windstorm (air- flow with velocities >60 km/h) and hail (among others), though by the late 1990s flooding and other large scale extreme weather events were being excluded from general coverage. Private insurance companies provide limited coverage for extreme weather events. For example, most insurance companies cover for damages to private buildings and households up to a sum between 3700 EUR and 15 000 EUR, with a few insurers compensating up to 50% of the insured sum (Gruber, 2008). Business entities are granted more flexible contract conditions than private households, in particular since they have access to combined policies (specifically "all risk policies"), hence, higher coverage against losses resulting from natural hazards is available. When requested, cover can be extended to a fixed maximum sum amounting to 20 000 EUR or 25−50% of the building value.

*Table A2.1 Attribute table for Austria*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | N/a |
| **Hazard(s) covered** | Flooding; Storms; Hail | Flooding; Storms; Hail | Hail (all); Storm (some), Flood (some), Rain (some), Drought (some), Frost(some) |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Private bundled indemnity insurance | Private indemnity insurance, bundled for small and median enterprises. | Single risk hail and multi-peril insurance is mutual indemnity insurance. |
| **Compulsory vs. voluntary** | Voluntary: voluntary windstorm insurance is automatically included in standard household policies, flooding is a voluntary and limited extension. | Voluntary: Coverage is a voluntary extension. | Voluntary |
| **Damage covered** | Direct damage to buildings and contents. | Direct damage to buildings and contents. | Damage to crops and production losses. |
| **Limit of compensation** | For floods: Maximum indemnification applied to buildings a fixed amount, generally ranging from €5,000 to €15,000. Indemnification limits for contents are similar to those for buildings. May be further limited in particularly high risk areas. | For floods: Maximum indemnification applied to buildings can be a percentage (up to 50%) of the capital insured, or a fixed amount, generally ranging from €5000 to €15,000. Indemnification limits for contents are similar to those for buildings, tough there is slightly more flexibility than compared to household insurance (e.g. can be extended to a max coverage of €20,000).<br><br>May be further limited in particularly high risk areas. | Compensation is limited by the chosen sum insured per field. |
| **Individual policy deductibles** | | | |
| **Risk Reduction Incentive based on: Premiums** | Deductibles; risk exclusions in terms and conditions | Deductibles; risk exclusions in terms and conditions | Bonus-malus system, deductibles |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Deductibles Other** | | | |
| **Market penetration rate** | Flooding: <10% sum insured, but >85% of risks insured Storms/Hail: >85% sum insured and risks insured | Penetration rate could be around 65% | Arable Farming: 60% for multi-peril insurance (hail reaches about 80%) |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Storm insurance tends to not be risk dependent.<br><br>Premiums are not dependent on risk. The use of risk zoning for pricing purpose is under consideration. | Risk based | Premiums are risk based. 50% of the premium is subsidized (split between the federal and regional governments). |
| **Reinsurance access: Private reinsurance Public reinsurance** | Private reinsurance, No reinsurance for the Naturkatastrophenfonds | Private reinsurance | Private Reinsurance mixture of stop loss contracts and proportional contracts. |
| **Average annual premium** | Average property premium per capita in 2015 = ~320 EUR | | Depends on chosen product:<br>Single risk hail insurance: 3,0% of total sum insured.<br><br>Multi-peril insurance: 3.9% of total sum insured.<br><br>Multi-peril insurance: Total average premium of about €57 per hectare. (ca) |
| **Access to public disaster response fund** | Yes, catastrophe fund compensates 20-30% of losses suffered. However, no formal rules to guide the decision.<br><br>In principle the responsibility for coping with the damage caused by NatCat is attributed to the Länder, but in 1966 the Disaster Fund was settled. The main aims of the Fund are:<br>- Finance preventive measures against avalanches and floods.<br>- Support the Länder in covering incurred losses.<br><br>Fund's interventions<br>Private properties. Private households and companies are usually granted 20-30% indemnity for the incurred loss by the Länder. The Disaster Fund then reimburses 60% of the financial aids spent by the Länder.<br><br>Public properties. The Fund compensates 50% of the | Yes, catastrophe fund compensates 20-30% of losses suffered. However, no formal rules to guide the decision. | If a disaster is officially declared to be a catastrophe the farmer may get compensation if the damage surpasses 1.000 € per farm, but there is no legal title to get compensation. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | damage to Länder and municipal property.<br><br>In case of extreme situations, the Austrian Parliament easily grants additional resources via public funds and / or tax relief, thus depending on pure political decision | | |
| **Pay-out speed** | | | Payment within 4 days after claims settlement. |
| **Additional comments** | The post-disaster Naturkatastrophenfonds (as far as it covers private property) is major obstacle for the development of a pre-disaster NatCat insurance compensation scheme | | Farmers have to insure all of their arable land. |

*References: Mahul and Stutley (2008); Diaz-Caneja et al. (2009); Maccaferri et al., (2012); Lamond and Penning-Rowsell (2014); Wharton Risk Management and Decision Processes Center (2016); Porrini and Schwarze (2012)*

### *Bulgaria*

Bulgaria has an insurance sector that is slightly less developed than other European countries (the participation rate is 2.1% of per capita income vs. 7.6% on average across the EU). The Insurance Act of 1997 was revoked due to the adoption of a new Insurance Code, which came into effect on January 1, 2006. Under this code insurance companies can approach extreme weather events by: setting higher solvency requirements; developing equalization reserves; the use of reinsurance; and directly excluding extreme weather events from coverage. There is strong international presence in the Bulgarian insurance market on the whole as foreign investors have acquired shares in most of the Bulgarian insurance companies or provide reinsurance.

Bulgaria has examples of compulsory insurance however these tend to be for automobiles or work related accidents, but not for other property related losses. Furthermore, each governmental ministry also has set provisions for a minimum level of insurance coverage for their employees in terms of their safely, e.g. volunteers during natural disasters. There are some compulsory insurance products in terms of protecting farmers, i.e. leases, oil storages, local dams maintained by agricultural associations. In some cases there is a dialogue regarding new insurance products (e.g. a potential income insurance for farmers). Fire and natural disaster insurance comprise approximately 12 percent of gross written premiums, corresponding to at most ~10% of the eligible population (though quite possibly lower in higher risk areas). There are very few products that specifically cover losses from flooding events and droughts as it is difficult to disentangle what a particular policy covers. In the case of agricultural insurance, the majority of coverage is against hail losses.

However, it must be noted that due to the republican fund that provides compensation charity hazard can have a large impact on the number of household's wishing to buy insurance. For example, between 2007 and 2013 the Bulgarian government spent ~32mil EUR on state aid as compensation for agricultural losses. This creates interplay between ex-post and ex-ante measures.

*Table A2.2 Attribute table for Bulgaria*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | N/a |
| **Hazard(s) covered** | Flooding; Storms | Flooding; Storms | Hail (most common); Storm; Torrential rain; Frost |
| **Official trigger**<br><br>**Yes /no**<br><br>**Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Single risk indemnity insurance | Single risk indemnity insurance | Single risk indemnity insurance<br><br>Combined risk indemnity insurance |
| **Compulsory vs. voluntary** | Voluntary extension of property insurance | Voluntary extension of property insurance | Voluntary (required for access to government subsidies and history of compulsory insurance) |
| **Damage covered** | Direct damage to buildings and contents | Direct damage to buildings and contents | Damage to crops |
| **Limit of compensation** | In theory no limits on compensation. However, coverage tends to be a max of 85% of the potentially insured value. | | Up to insured value |
| **Individual policy deductibles** | Up to 2% of insured value. Many insurance companies may not apply any deductible. | | 5% of insured value |
| **Risk Reduction Incentive based on:**<br><br>**Premiums**<br><br>**Deductibles**<br><br>**Other** | Deductibles | Deductibles | Deductibles<br><br>Bonus-malus system (i.e. no claims bonus) |
| **Market penetration rate** | ~10% for flood insurance (at least less than 20%) | | ~27% of farms<br><br>~50% of total |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | ~10% for storm insurance (at least less than 20%) | | cultivated area |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Commonly a flat rate as a percentage of the insured value.<br><br>There are limited examples of where flood insurance premiums increase based on proximity to rivers. | | No subsidy for arable crops.<br><br>Subsidies of up to 80% on insurance for vegetables and fruit.<br><br>Hail insurance tends to be priced across risk zones. |
| **Reinsurance access:**<br><br>**Private reinsurance**<br><br>**Public reinsurance** | Private reinsurance access | Private reinsurance access | Private reinsurance access |
| **Average annual premium** | ~25-50 EUR, additional extensions for flood and storms at €20 (each) | ~€20 per extension | ~4.8% of insured value (~€5per hectare) |
| **Access to public disaster response fund** | There is the possibility of receiving ad-hoc compensation from the Republican fund. In 2008 this fund was valued at $31M, but is funded by government appropriations. | | There is the possibility of receiving ad-hoc compensation from the Republican fund. In 2008 this fund was valued at $31M, but is funded by government appropriations. |
| **Pay-out speed** | Within 15 days of claim received | Within 15 days of claim received | Aims to be within 15 days after harvest/claim received. |

*References: Mahul and Stutley (2008); Diaz-Caneja et al. (2009); EC (2014); Lefebvre et al., (2014); Maccaferri et al., (2012); DG Interrnal (2016)*

***Denmark***

Denmark with only 5,5 million inhabitants in recent years experienced high costs on weather related damages amounting to at least 35 billion DKK (~ 7,7 billion EUR) since 1999. In particular, one cloudburst in Copenhagen on 2 July 2011 made insurance companies pay for 90.000 damages at the total cost of 6,2 billion DKK (~ 832 million EUR). The increase in events and damages has urged for an advance risk management system combining innovative mechanisms, the participation of both public and private actors and their enhanced collaboration.

Aligned with this, Denmark employs a mixture of compulsory and voluntary insurance. There is a tendency to move towards micro rating insurance. After heavy floods in 2010 and 2011 many companies introduced restrictions on coverage in basements and, in certain cases, technical demands, e.g. backflow valves on the sewage system. Further, the industry foresees restrictions on coverage for certain future events, unless the necessary climate adaptation measures are taken.

Denmark has an independent council, The Danish Storm Council, established in pursuance of the Danish act relating to storm surges and windfall. This intergovernmental body decides based on scientific evidence from technical experts, whether a storm event may be considered as an event involving public compensation for damage costs. If a storm is considered a 20-year event with a probability of happening every 20 years, the Storm Council may liberate funds based on individual request from private estate owners.

The Storm Council handles cases involving compensation following flooding from waterways and lakes as well as subsidies for reforestation after windfall. It also supervises and considers complaints about insurance companies' processing of storm surge cases. It is appointed by the Danish Minister for Business and Growth and consists of an independent chair and eight other members. Its members represent insurance companies, citizens, municipalities and ministries. The Storm Council covers damages through the public storm surge scheme. The scheme is financed by an annual taxof 7 EUR (30+20 DKK per year per policy) included in the insured's fire insurance policy (which is mandatory for property owners). In regards to compensation payments, insurance companies manage them on behalf of the Storm Council. Should there however be a disagreement between the insurance holder and the insurance company, the Storm Council may interfere.

With regard to reforestation in relation to windfall in forests, criteria stipulate that you must have taken out insurance against storm damage on trees, and the insurance must cover the entire area in which your trees have been overturned. Your forest must also be a protected forest, and the area overturned by the storm must be greater than 1/60 of the total forest area.

*Table A2.3 Attribute table for Denmark*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | Private insurers<br>Danish Storm Council | Private insurers<br>Danish Storm Council | N/a |
| **Hazard(s) covered** | Storm council: Storms (flooding from rivers and seas) | Storm council: Storms (flooding from water ways and seas), windstorms affecting forests | Private insurance: water risks; Hail (most common) |
| **Official trigger Yes /no Description?** | The Danish Storm Council: Yes, if the storm is declared to be a 1/20 year event. | The Danish Storm Council: Yes, if the storm is declared to be a 1/20 year event. | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Indemnity insurance<br>The Danish Storm Council: bundled indemnity insurance | Indemnity insurance<br>The Danish Storm Council: bundled indemnity insurance | Single risk |
| **Compulsory vs. voluntary** | Private market: voluntary<br>The Danish Storm Council: Tied with compulsory fire insurance. | Voluntary | Voluntary |
| **Damage covered** | Direct damage to buildings and contents | Direct damage to buildings and contents<br>Ref | Damage to crops |
| **Limit of compensation** | | | |
| **Individual policy deductibles** | The deductible for flooding is the minimum of 5% of the loss or ~€ 700 (as of 2010) for single or two-family homes and for personal effects, doubling for all the other properties. | Minimum of 10% of the loss or ~€1,400 for property and contents damage. | |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles | Deductibles | Deductibles |
| **Market penetration rate** | >90% of households, for storms. 50%-75% for Flood insurance. | | 80%-85% of cultivated area. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Limited insurance schemes are risk based | Limited insurance schemes are risk based | |
| **Reinsurance access: Private reinsurance Public reinsurance** | The compensation for coastal flooding is protected by a limited state grantee (~€27M). The remaining risks is covered by private reinsurance. | Access to private reinsurance | Access to private reinsurance |
| **Average annual premium** | Average property premium per capita in 2015 = ~290 EUR | | |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | Coastal flooding has a cost of ~€2.70 (a surcharge of ~€1.35 if the state grantee is used). | | |
| **Access to public disaster response fund** | Indirect access for river flooding if the household is not insured and the flood was sufficiently rate. | | If the farm was insured there can be access to subsidies for replacement or cleaning costs. |
| **Pay-out speed** | | | Pay-out is aimed to be completed by harvest at the latest. |
| **Additional comments** | | | No real multi-peril agricultural insurance. |

*References: Diaz-Caneja et al. (2009); Lamond and Penning-Rowsell, (2014); Danish Storm Council (2017); Maccaferri et al., (2012); Svensk Forsakring (2013);*

### *France*

*Overall Description*

France is characterized by a widely successful public-private sector partnership in providing affordable insurance and high penetration rates (~100% for property insurance and ~50-75% for business interruption), due to its focus on national solidarity and strong public sector influence. Since 1982[19], all households and business who enter into a contract of insurance covering damage to property or business are also covered against the effects of most major disasters (floods, droughts, earthquakes, etc.).

Weather related disasters are covered though three main insurance schemes:

(1) The CatNat scheme includes in its scope the coverage of the majority of extreme weather events (except storm, snow, and hail) for households, businesses and agricultural enterprises. It covers buildings, as well as their contents, vehicles and business interruption, when insured against fire. A compulsory extension to property insurance, CatNat is provided by private insurance companies and funded through a flat rate surcharge (i.e. 12 % on building and contents insurance) over existent policies against property damages (respectively business interruption). Insurers are free to choose a reinsurance scheme but the Caisse Centrale de Reassurance (CCR) benefits from the state guarantee which provides with a monopolistic advantage. CatNat offers low-priced (re)insurance and channels part of the resources into a state-managed fund for natural risk prevention (see also below). In this scheme, compensations for natural disasters have to satisfy two conditions: a natural disaster must be recognized by an inter-ministerial decree and the property affected must be covered by a "property damage" insurance policy.

(2) The Regime des Calamites Agricoles (Agricultural Calamity scheme) offers specific compensation for non-insurable bio-assetsof farmers (crops and livestock) through the National Fund for the Management of Agricultural Risks. In this scheme, compensations for natural disasters have to satisfy two conditions: an agricultural calamity must be recognized by a decree from the ministry of agriculture and the farm business affected must be covered by an insurance policy (e.g. fire, crop or livestock insurance).

(3) The Garantie tempete, grele, neige (TGN) covers risks related to storm, weight of snow on roofs and hail. While the market is free, insurers are under the obligation to offer it as an extension of the property insurance (it is integrated in the multi-risks part of the insurance cover).

In average since 1989 the insurance and reinsurance sector paid for 1,9 billion EUR damages per year. In 2010, the storm Xyntia generated 2,7 billion EUR payments, including 50% through TGN and 50% CatNat (CCR, 2015). Since the creation of CatNat on 1982, the insurance sector has been able to cover all losses, except once in 1999, when the State guarantee provided to CCR was used.

In order to limit adverse selection and mitigate for the moral hazard created by flat rate premiums and state guarantee and maintain this high level of insurance, the national government, territories and economic players put a high emphasis on prevention efforts, at their distinct level of responsibility.

*Strategies for Risk Reduction*

Since the creation of the NatCat compensation scheme in 1982, France has applied a flat premium for fire risks or multi-peril policies and compulsory cover. Insurers are free to determine the policy premium. The flat surcharge is 12% and 6% for motor insurance with own damage cover (fire and/or theft). The problem of moral hazard is exacerbated by the compulsory extension of cover which is provided at a flat premium not linked to the level of loss prevention at the insured risk. In order to avoid the problem of moral hazard: (1) The

[19] Loi n° 82-600 du 13 juillet 1982 relative à l'indemnisation des victimes de catastrophes naturelles

reinsurance programmes with the CCR (guaranteed by the State) have evolved towards a greater sharing of fortunes between Cedant and Reinsurer, (2) The benefit of a direct insurance extension against natural disasters (CatNat) is provided subject to a compulsory deductible for an amount set by the State, with no buy-back option (FFSA, 2013)

Deductibles can be adjusted according to risk profile; this possibility offered to insurance companies is however restricted and subject to centralised procedures, through the Bureau Central de Tarification (BCT) which can set higher deductibles. Nevertheless, in reality this prerogative is hardly applied. In addition, Insurers can invoke BCT in case of non-compliance with the PPR(N) ("plan de prevention des risques (naturels)") prepared by the French national administration At prefectural level (département) The PPR identifies areas at risk and should be followed up by preventive actions by policy holders or competent local authorities. In case a PPRN has been prescribed by the prefect but is not yet adopted (by prefectoral decree), due to instruction delays), deductibles are significantly increased for relevant areas (factor 2 to 4) at the administrative recognition of a new NatCat event, according to the record of previous NatCat events at the same municipalities.

A small part of the CatNat guarantee extension (12% of it) contributes to the Fonds de Prévention des Risques Naturels Prévisibles (FPRNM, so called "Barnier fund"). The fund finances preventive actions taken including PAPI (Programme d'Action de Prévention des Inondations). PAPI imply a voluntary collaboration between various territorial actors to implement a complete series of structural and non-structural flood risk reduction actions at river basin or coastal level . The Barnier fund was initially criticised for not really financing hard prevention measures (such as resilient infrastructure investments) and for its lack of transparency, as it was initially designed to finance expropriation only, but it is currently being eligible for many other purposes, with a current emphasis on measures at territorial level, rather than at individual level, as long as insureds do not perceive a priority in the increase of risk resilience for their assets.

Another tool for risk reduction is the creation of The Observatoire National des Risques Naturels (ONRN) created in 2012 as a partnership between the Ministry of Environment, the CCR and the insurance industry (via Mission Risques Naturels), to monitor the exposure of assets and territories, the loss records at various scales including the event one and to evaluate public policies. It aims to contribute to the general increase of risk awareness and culture through the generation and dissemination of knowledge and data on natural hazards.

Overall the involvement of French insurance industry to NatCat risk management is fairly integrated, addressing together risk transfer (high penetration), Disaster risk reduction financing resources collection and allocation, and disaster risk reduction financing knowledge and data sharing for a better governance. In floods, the risk reduction measures tend more and more to compensate for the moral hazard created by flat rate premiums.

*Approaches for increased resilience*

One way forward to address moral hazard would be to completely disconnect the affordability objective (through subsidies) from the risk prevention objective, by the means of avariable premium dependant to both hazard exposure and asset vulnerability,. However this would require a deep reform of the French system, which is not foreseen, at least for the mass risks, considering the very low average level of premium paid for Nat Cat (of an average annual premium of 200 to 300 €, for property damage multirisk line). One major obstacle to this is for course public acceptance for a significant increase of annual premium in exposed areas. Work is ongoing in terms of data and data sharing. The Observatoire National des Risques Naturels now publishes insured loss and prevention data (at municipality grid), provides support to risk reduction decision making and participative governance. Both CCR and FFA recently produced their modelling-based studies of costs forecast in 2040, respectively 2050 for the main weather perils likely to be affected by climate change (CCR, 2015 ; FFA, 2015). Increasing competencies are transferred from state authorities to the local level. Increasing financial support has been provided by the so-called Barnier fund to subsidize the State contribution to the PPR and PAPI policies. Moreover, a law passed in January 2014, on the modernization of public action creating a targeted and compulsory competence relating to the management of aquatic environments and flood prevention assigning it to municipalities and their associations and allowing local authorities to raise taxes, and this may ultimately have a further impact on the prioritization of risk management investments between territories and ultimately on risk transfer, if the target of reducing the average annual cost of losses tends to be hit.

In France, the involvement of the insurance industry representatives in every step of the public disaster risk reduction policy remains a key approach for increasing resilience through enhanced collaboration between the public and the private sector.

*Table A2.4 Attribute table for France*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | Catastrophes Naturelles (CatNat), 1982 Garantie TGN (Tempete, Grele, Neige) | Catastrophes Naturelles (CatNat), 1982 | Catastrophes Naturelles (CatNat), 1982 Garantie TGN (Tempete, Grele, Neige) |
| **Hazard(s) covered** | CatNat: All non-insurable risks (majority of extreme weather events) TGN: Storms, hail, weight of snow on roofs | CatNat: All non-insurable risks (majority of extreme weather events) TGN: Storms, hail, weight of snow on roofs | FNGRA: Farm losses (crop damage) by what can be considered non-insurable (all the studied disasters except for storms (wind and hail)). |
| **Official trigger Yes /no Description?** | CatNat: Yes, must be an officially declared disaster TGN: Contractual triggering clause | CatNat: Yes, must be an officially declared disaster TGN: Contractual triggering clause | FNGRA: Yes |
| **Type of insurance, e.g. bundled, parametric triggers** | Bundled cover as a compulsory extension to property damage insurance. | Bundled cover as a compulsory extension to property damage and business interruption insurance. | Crop yield / livestock insurance |
| **Compulsory vs. voluntary** | Compulsory extended coverage with property insurance. | Compulsory extended coverage with property insurance and / or business interruption. | Crop insurance is voluntary. However, all plots of the same crop must be insured. |
| **Damage covered** | Damage to household/buildings property and contents. | Damage to property buildings and contents, separate policy for business interruption. Applicable to agricultural sector. | Production losses due to extreme weather events. |
| **Limit of compensation** | Policy limit: total insured value | Policy limit: total insured value | Policy limit: total insured value can be set by the farmer but the indemnification is a fixed percentage ranging from 12% to 35%, though it can go higher if several disaster events are declared in a short period. However, the more extreme the loss the greater the indemnification. |
| **Individual policy deductibles** | €380 for private households. Specific higher deductible for subsidence (1040 €) | 10 % of property damage with a minimum of €1,140.<br><br>3 days with a minimum of €1,140 for business interruption. | Crop insurance policies have a deductible/franchise that requires the yield loss to be at least 30% or larger before payments begin. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Increased deductible in case of several recent declaration of event in the same category of hazard at a municipality not covered by a PPRN prescribed. Stronger incentives for risk management at the community level. | Increased deductible in case of several recent declaration of event in the same category of hazard at a municipality not covered by a PPRN prescribed Stronger incentives for risk management at the community level. | Deductibles |
| **Market penetration rate** | ~100% for property insurance. | ~90% for property insurance.<br>~50-75% for business interruption. | Between 25%-55% of cultivated area for per crops, for a total of about 30% of cultivated area. Field crops are most commonly insured, while fruits are the least insured. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Flat Premium rate (12% surcharge of property insurance premium). | Flat Premium rate (12% surcharge of property damage and/or Business interruption insurance premium). | Crop premium rates differ per crop and location. However, the premiums are subsidized up to 65%. The premium could be an average of €8 EUR per hectare across crops |
| **Reinsurance access: Private reinsurance Public reinsurance** | Yes (either separately from the CCR scheme or as a complement to the CCR scheme). Reinsurance by the CCR with unlimited state guarantee.<br><br>Insurable climate risks on the private reinsurance market. | Yes (either separately from the CCR scheme or as a complement to the CCR scheme). Reinsurance by the CCR with unlimited state guarantee.<br><br>Insurable climate risks on the private reinsurance market. | Yes (either separately from the CCR scheme or as a complement to the CCR scheme). Reinsurance by the CCR with unlimited state guarantee.<br><br>Insurable climate risks on the private reinsurance market. |
| **Average annual premium** | About 20 to 50 EUR in case of a private individual house(and contents) for the CatNat extension<br><br>Average property premium per capita in 2015 = ~250 EUR (baseline property premium = ~220 EUR) | About 30 EUR p.a. but e extreme dispersion in sizes of insured assets | In 2013 field crops paid an average of €42 per hectare, while vegetables paid €1,406 per hectare. |
| **Access to public disaster response fund** | No | No | If a farm is already covered by the FNGRA then a very severe disaster can be asked to be considered as such and additional compensation or additional recovery costs may be compensated. |
| **Pay-out speed** | Less than 3 month after claim received or disaster declaration. | Less than 3 month after claim received or disaster declaration, longer delays in specific | Agricultural insurers intend to pay claims within 1 month after harvest. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | | cases of BI claims. | |
| **Additional comments** | Deductible can vary :<br>- on a case by case basis, if multiple claims or if measures prescribed by PPRN are not put in practice by the insured and/or the municipality<br>- At community level depending to the status of PPRN<br>NB. Building codes are tailored according to risk zones according to the relevant PPRN | | |

*References: UN (2008); Diaz-Caneja et al. (2009); Enjolras and Sentis (2011); Maccaferri et al., (2012); EC (2014); Wharton Risk Management and Decision Processes Center (2016); World Bank (2012); insurance Europe consultation; DG Internal Policies (2016)*

### *Germany*

Before the reunification of Germany there was a sharp divide between East and West Germany. In East Germany there was a state run monopoly with fixed flat rate premiums and the government as re-insurer of the last resort, the purpose of which was the socialized losses in order to provide widespread extreme weather insurance for both property and contents. Under this arrangement prevention measures were irrelevant. While in West Germany, there was a combination of statutory public bodies, which acted as monopoly fire insurers, and private insurers. The premium were permitted to be risk based by the regulators, but both premium calculations and the terms and conditions of such policies where strictly supervised. The strict supervision limited extreme weather insurance to only wind and hailstorms. The reasoning behind the strict supervision was fear of negative selection, preventing certain customers from being able to access insurance coverage. However, there was an exception in Baden-Wurttemberg that required mandatory extreme weather insurance. Additionally, unlike in East Germany the employment of prevention measures was the responsibility of both individuals and governments.

After the German reunification in 1990, the fears of negative selection was no longer viable due to the large number of polices enforce in East Germany. The presence of many East German policies allowed for the creation of a sufficient risk pool, and general nationwide extreme weather insurance was allowed in 1991. In 1994 the public monopolies were disbanded and transferred to private insurance companies. From 1991 to 2001 the German insurance industry was in the initial stages of increasing their experience of extreme weather outside of hail and windstorms. The industry and regulators agreed on the potential wording of extreme weather insurance policies ("Erweiterte Elementarschadenversicherung") allowing the market to provide insurance for other extreme weather events.

Currently, German insurers continue to provide windstorm and hail insurance as a part of a standard private building insurance policy (i.e. that covering fire, escape of water etc). However, coverage against more extreme weather events such as floods is insured as a voluntary extension of the policy. The extension tends to be risk based, with the possibility of higher excesses, so that the premium remains attractive for the policyholder. However, the penetration of this extension is moderate because of a mixture of low risk perceptions and ad-hoc government support after large scale disaster events that introduce an element of charity hazard into the market. After the major flooding in 2002 the estimated penetration rate of flood insurance (for example) was ~15% (of private households) however exposure to several other large scale events, combined with attempts to increase risk awareness has led to a penetration rate of ~40% of households (~43% including sole covers against torrential rain) in the end of 2016 – steadily rising.

*Table A2.5 Attribute table for Germany*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | Nationwide NatCat Insurance from 1991 on (storm an hail for many decades) | Nationwide NatCat Insurance from 1991 on (storm an hail for many decades) | Crop insurance against hailstorm is the most developed |
| **Hazard(s) covered** | Flooding (including heavy rains and backwater)<br>Earthquakes, subsidence, landslides<br>Snow pressure, avalanches<br>Volcanic eruptions, storm, hail | Flooding (including heavy rains and backwater)<br>Earthquakes, subsidence, landslides<br>Snow pressure, avalanches<br>Volcanic eruptions, storm, hail | Mostly Hail, but multi-peril crop insurance also available |
| **Official trigger Yes /no Description?** | No (solely based on insurance terms and conditions) | No (solely based on insurance terms and conditions) | No (solely based on insurance terms and conditions) |
| **Type of insurance, e.g. bundled, parametric triggers** | Private bundled (and single risk) indemnity insurance | Private indemnity insurance | Single risk yield insurance |
| **Compulsory vs. voluntary** | Storm and hail damage tend to be automatically included in standard property insurance.<br><br>Flood insurance and all the other natcat perils are a voluntary extension. | Storm and hail damage tend to be automatically included in standard property insurance.<br><br>Flood insurance and all the other natcat perils are a voluntary extension. | Voluntary |
| **Damage covered** | Direct damage to buildings and contents | Direct damage to buildings and contents; Business interruption | Production losses due to crop damage. |
| **Limit of compensation** | The total insured value | The total insured value | |
| **Individual policy deductibles** | Floods: on average 10% of total damage. Ranged between €500 and €5,000 regarding floods. Windstorms and hail tends to not have a large deductible. | Windstorms and hail tends to not have a deductible, while flooding related risks tends to have deductibles. | 8% of total insured value for cereal crops. Vegetables and fruits range between 10-25% of insured value. |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles<br>Premium discounts (less common than in commercial sector)<br>Individual preventions measures | Deductibles<br>Premium discounts<br>Individual preventions measures | Bonus-malus deductibles |
| **Market penetration rate** | Coverage for storm and hail is over 95%, while for flooding it is ~40% of households (for building insurance) Regarding flood insurance the penetration rates are traditionally higher in former East Germany as compared to West Germany. | Coverage for storm and hail is over 95%, while for flooding it is ~40% of households (for building insurance). | In 2005 hail insurance represented about 60% of farm land. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Risk based (risk zoning is employed) | Risk based | Risk based |
| **Reinsurance access: Private reinsurance Public reinsurance** | Private reinsurance | Private reinsurance | Private reinsurance on a quota-share or stop-loss basis. There are no constraints for access to the international private reinsurance market. |
| **Average annual premium** | Average property premium per capita in 2015 = ~225 EUR<br><br>< €100 for approx. 90% of all buildings (lowest risk zones), further 8% approx. €150-200, remaining 2 % highest risk zones up to € 700 p.a. on average | | On average 1.2% of insured value, about €18 per hectare. |
| **Access to public disaster response fund** | Yes, the German government can provide ad-hoc disaster compensation after an event. | Yes, the German government can provide ad-hoc disaster compensation after an event. | Yes, the German government can provide ad-hoc disaster compensation after an event. |
| **Pay-out speed** | By law, insurance industry has to pay out significant part of the compensation after one month, nearly all claims settled after one year. | By law, insurance industry has to pay out significant part of the compensation after one month, nearly all claims settled after one year. | Pay-out aims to be within 2-3 weeks after claim is processed, but by 2-3 weeks after harvest at the latest. |
| **Additional comments** | General collaboration between the German insurance association and several other bodies in order to develop mechanisms that raise risk awareness and understanding. Therefore, are also attempts to expand the understanding the policymakers have in regards to their own policy. | | Only limited market competition in terms of the number of companies involved.<br><br>Mainly provided through cooperatives and farmers associations. |

*References: Mahul and Stutley (2008); Diaz-Caneja et al. (2009); Schaffnit-Chatterjee (2010); Maccaferri et al., (2012); Keskitalo et al. (2014); Wharton Risk Management and Decision Processes Center (2016); Hudson et al. (2017); Insurance Europe consultation*

### *Hungary*

In 2009 the overall size of the premiums collected by the Hungarian insurance market as a ratio to GDP was 3.3% which was in line with other central and eastern European countries, though smaller than the EU as a whole (which stood at 8.9%). While the percentage of premiums as a proportion of GDP is rather low, in terms of coverage against extreme weather events ~75% of households with general household insurance have coverage against flooding, storms, hail as a standard element. In principle, the purchase of general household insurance is voluntary. Though, the increase use of mortgages requiring complete coverage has been increasing the penetration rate over time. The premiums tend to be independent of the risk faced by a particular policyholder as coverage is extended as a flat rate percentage of the general property premium, due to competition concerns as well as the cross-subsidization of high and low risks that is achieved through the widespread coverage. There are many insurance companies who are unwilling to provide insurance against flooding in highly flood problem areas, such as bulidings located in floodway's (though other extreme weather events are insured against). To prevent these households from not gaining insurance the Hungarian government has created a compensation fund (Wesselenyi Miklos Ar-es Belvizvedelmi Alap) for these high risk residential properties who must pay into the fund in order to gain access, though the participation rate remained small (only a few hundred contacts). However, since 01/01/2017 no new contracts will be provided, only those taken out before 01/01/2017 will continue to be inforce until these policies expire.

Crop insurance has been avaiable since 1830 in various forms. However, the National subsidy for agricultural insurances in Hungary was first introduced in 1996, but this form of subsidisation was ended in 2003. A new system was built by 2007/8 with the name of National Agriculture damage Compensation (NAR) that covered crop losses from droughts, inland waters and frost via compulsory participation but limited compensation. In 2012 the system was reformed into the Complex Agricultural Risk Management System (MKR), which is a partnership between the NAR and private insurance companies. There are two pillars to the MKR: state provided compensation; private insurance compensation. Farmers are eligible to receive compensation from the first pillar if they suffer a yield loss of at least 30% due to extreme weather events at the crop level, and if the sum of crop losses were at least 15% compared to the 3 previous years at the farm level. Farmers can claim for losses from droughts, floods, hail, storms and frost. The state provided coverage has a penetration rate of about 80% of total arable land. The second pillar of the scheme is private insurance coverage, which is a voluntary choice of individual farmers and subsidised by the state. The basic loss threshold is 30% for hail and storms, while floods and droughts stand at 50%by this type of insurance. The voluntary extension can provide coverage for a greater range of crops and the specific perils that the farmer wishes to insure. The penetration rate of this private but subsidised insurance is smaller at ~50% of total arable land. The penetration of non-subsidised insurances is decreasing, but it reaches 20% of total arable land nowadays. However, it must be noted that under the MKR system the total compensation for a loss is split between the NAR and private insurers. The farmer receives first from insurance a payment, than the remained loss is compensated by the NAR. However, a farmer that does not buy private insurance can only be compensated for 50% of the loss suffered. So the farmers are motivated by the state to buy insurances.

***Table A2.6 Attribute table for Hungary***

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | Agricultural Risk Management System : Pillar 1 (government calamity fund); Pillar 2 (private insurance coverage) |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Hazard(s) covered** | Cloudburst; Floods; Windstorms, Hail | Floods; Storms; Other natural disasters | Hail; Frost; Storm; Drought; Flood |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Bundled (and single risk) indemnity insurance combined with property insurance | Bundled with all-risk property policies | Single risk yield insurance (pillar 1)<br><br>Combined risk yield insurance (pillar 1 and pillar 2) |
| **Compulsory vs. voluntary** | Voluntary (required for mortgages) | Voluntary (required for mortgages) | Private insurance coverage is voluntary.<br><br>However, the Pillar 1 is compulsory if the farm is over 10 hectares. |
| **Damage covered** | Direct damage to buildings and contents based on replacement cost or repair values. | Direct damage to buildings and contents. | Damage to crops |
| **Limit of compensation** | Total insured value based on property prices (in 1990). Limit for the sum insured tends to be around ~€96,000 | Total insured value. Limit tends to be around ~€380,000 | Pillar 1: 50%-80% of loss<br>Pillar 2: the remainder |
| **Individual policy deductibles** | Often there are no deductibles as it forms on optional part of the policy. The average deductible ranges from between 60 EUR to 160 EUR per claim. | None that can be directly observed. | There are different damage thresholds per extreme weather event and crop type - average about 10%. |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles | Deductibles | Deductibles |
| **Market penetration rate** | 70%-75% of households | | About 50% of insured arable land in the private insurance pillar, ~80% of arable land for the governmental pillar |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Rates more driven by competitive pressures rather than technical requirements. | | The private insurance element has free pricing with some government subsidies.<br><br>All risk premiums are set at a regional level, while risks are set at the national level in Pillar 1. (currently undergoing changes) |
| **Reinsurance access:** | Private reinsurance, generally stop- | Access to private | Private reinsurance |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Private reinsurance Public reinsurance** | loss reinsurance for events with a return period of between 1/200-1/250 or smaller. | reinsurance. | that is quite varied across insurers. |
| **Average annual premium** | Average property premium per capita in 2015 was ~50 EUR per capita for buildings, ~100 EUR per year for combined building/contents insurance.<br><br>Average premium rate (for buildings insurance) for an all-perils-policy is 1.06 per mile. | Average of 1.1% of insured value | (median value) is 4.3% of insured value in 2007<br><br>Private insurance coverage was €2,200 on average between 2012 and 2015.<br><br>Access to government calamity fund on average, between 2012 and 2015, was about €180. It means 3,2 €/ha for arable land and 9,7€/ha for plantations and vegetables. |
| **Access to public disaster response fund** | The Wesselenyi Miklos compensation fund for floods and in-land waters protection. This fund provides government insurance in very high risk areas where insurance is not provided. They must pay a contribution to access this fund. Compensation is based on indemnity. Compensation limit is ~€83,000. However, since 01/01/2017 the fund does not provide new contracts. | | The government calamity fund is in place that acts as the first pillar of the scheme. |
| **Pay-out speed** | | | Pay-out aims to be within 30 days after an event or claim in Pillar 2. Compensations are paid within next year's March in Pillar 1. |
| **Additional comments** | Rapid expansion in recent years has been due to the expansion of mortgage backed buildings.<br><br>Households in high risk areas might be excluded from coverage. Truly uninsurable households have recourse to a state disaster fund (Wesselenyi Miklos Ar-es Belvizvedelmi). | | Limited competition in terms of the number of insurance companies offering insurance. |

*References: Mahul and Stutley (2008); Diaz-Caneja et al. (2009); Pollner (2012); OECD (2015); Kemeny et al., (2013); Kemeny et al. (2014); Wharton Risk Management and Decision Processes Center (2016); Maccaferri et al., (2012);*

### *Italy*

In Italy the general property insurance market is dominated by four firms (Generali, Unipol group, Allianz group and Reale Mutua) that between them cover 70% of the market. Though as natural disaster coverage is a voluntary extension of homeowners insurance, when combined with low risk perception and ad-hoc compensation, the overall penetration rate is quite low. The majority of policies cover losses such as storms and hail, while flood insurance policies are less common. However, for a flood in 2014 in Liguria and Emilia Romagna caused 320mil EUR in damage, of which 140mil EUR was compensated. Geographically, 2016 insurance exposure to natural disaster risk both for businesses and for dwellings is concentrated (some 65% of the total) in the North of Italy. There is significant exposure in the regions of the Center as well, however − about 25% for residential housing. Therefore, while the literature considers the insurance penetration rate low overall, there are occasions when there is a relatively high degree of compensation. A second example is that on 08/07/2015 the town of Dolo in the Venice metropolitan area was struck by a tornado, causing 25mil EUR in damage, of which 10mil EUR was covered by private insurance. However, on the whole the offer of specific policies for flood risk is held back by a series of problems − for instance the risk of adverse selection and difficulty in setting premiums. In Italy agricultural risk management has been coordinated by the National Solidarity Fund (managed by the Ministry of Agriculture) since 1970. The purpose of this body is to support agriculture financial loss prevention. The National Solidarity Fund (NSF) has both ex post and ex ante roles. The ex post role is to provide direct compensation, while its ex ante role is to support insurance coverage or provide support for risk reduction (after 2004 this subsidy has become more decentralised, an example is the use of anti-hail nets). The NSF can contribute up to 80% of the estimated insurance premium as a subsidy. The NSF draws a distinction between insurable risks and non-insurable risks, those which are insurable cannot receive ex-post compensation. Subsidies can be provided for single risk, combined risk, or multiple peril crop insurances, though ~88% of the insured value is through combined risk policy with the remaining 12% as multiple perils (in 2015). A farmer must insure all of their production within a municipality for at least a 30% production loss. The market is free to determine its own behaviour, though the ministry of agriculture decides what can be considered insurable as well as provide price guides on certain risk reduction measures (e.g. hail nets). In 2007 the Italian co-reinsurance pool was created to support the development of new insurance products in Italy. The pool divides the risks from these new policies between members, as well as a single entity that can be reinsured on the international market as well as comparing outcomes to similar products both domestic and abroad. The pool has a capacity of ~190mil EUR consisting of both insurance and reinsurance companies. The pool avoids competing with pre-existing insurance by only focusing on new products. Less than 20% of farmers are insured against extreme weather events (mostly located in the North of Italy), while ~80% of farmers are active on credit markets. The premiums collected in the agricultural market as a percentage of the insured value is ~5.4%.

***Table A2.7 Attribute table for Italy***

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | National Solidarity Fund (thereafter: FSN)<br><br>Private insurance<br><br>Co-insurance pool (ISMEA) |
| **Hazard(s) covered** | Flooding; Storms | Flooding; Storms | Hail; Storms; Frost; Floods; Excess Rain; Drought<br><br>The NSF only covers what the government has published to be non-insurable risks, the remaining risks are insured on the private market.<br><br>New insurance products can be supported via the co-insurance pool. |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Private indemnity insurance | Private indemnity insurance | Single or combined risk indemnity insurance. Limited yield insurance. |
| **Compulsory vs. voluntary** | Voluntary | Voluntary | Voluntary (must insure whole farm cropland) |
| **Damage covered** | Direct damage to buildings and contents | Direct damage to buildings and contents | Damage to crops |
| **Limit of compensation** | As for the indemnity limits, less than the amount of the rebuilding value is declared in the fire-coverage section of the policy. These limits, fixed by the companies or chosen by the clients with a premium that changes proportionally, fluctuate between a minimum of 50% and a maximum of 70% in case of housings. . | | Total insured value |
| **Individual policy deductibles** | The last point that deserves to be emphasized is the application of deductibles. They range from 5% to 20% of the value insured | | |
| **Risk Reduction Incentive based on: Premiums Deductibles** | Systematic presence of deductibles. | Systematic presence of deductibles. | Systematic presence of deductibles. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Other** | | | |
| **Market penetration rate** | <10%. About 50%%of overall national fire premiums come from personal lines and of this only 2% includes the natural catastrophe extension, t | Coverage against NatCat can be an extension of fire policies. The extension is quite common in commercial policies | Low (higher in the north as compared to the south). Few farms carry insurance for more than two consecutive years.<br><br>Theshare of insured value on total crop production has not exceeded 20% (on average<br>14% of value and<br>9% of surface area in total production for the period 2001–2012,<br>see Capitanio et al., 2011, 2013)<br><br>less than 20% of farmers seem to have insurance. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Very few policies are linked to the building typology (earthquake-proof, traditional, masonry), while the others don't regard the building structural performance limiting the degree to which premiums are risk based | | Premiums are subsidized (as long as the insurance covers losses in excess of 30% of historical annual production) by up to 80% (for combined perils). Average subsidy is 40% |
| **Reinsurance access: Private reinsurance Public reinsurance** | Access to private reinsurance | Access to private reinsurance | Access to private reinsurance for the insurance industry The FSN is backed by the ministry of agriculture.<br>ISMEA has a capacity of ~€190M. |
| **Average annual premium** | Average property premium per capita in 2015 = ~80 EUR | | Average premiums range from between 6.1% of insured value to 11.4% of insured value. The premium rate differs across crops. |
| **Pay-out speed** | The time accident statement is required by the homeowners within a time span ranging between three and ten days. The damages can be assessed by private contracts or experts appointed by the parties, and the payments are scheduled to be liquidated within 30 days from the agreement between the parties or the administrative check of the coverage. | | |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | However, the householders can obtain an advance payment on damage claim amounting to a maximum of 50% of the expected indemnity. | | |
| **Additional comments** | SIGRA - Flood insurance and risk man scheme; supported by ad-hoc governmental Assistance.<br><br>Insurance companies are obliged to set aside reserves for NatCat, Such reserves are tax-deductibles.<br>The FSN can provide ex-post payments for risks deemed uninsurable (must be recognized as a disaster by central government).<br><br>Ex-post interventions lead to underestimation of the risks potentially faced. | Insurance companies are obliged to set aside reserves for NatCat, Such reserves are tax-deductibles. | Insurance companies are obliged to set aside reserves for NatCat, Such reserves are tax-deductibles.<br><br>The FSN can provide ex-post payments for risks deemed uninsurable, crop risks are deemed insurable. |

*References: Diaz-Caneja et al. (2009); Maccaferri et al., (2012); Di Falco et al., (2014); Landini, (2015); Menapace et al. (2016); Santeramo et al., (2016);*

### *Poland*

Due to the growing use of mortgages for new buildings the insurance penetration rate reaches ~63% (with policies generally covering a bundle of extreme weather events), even if the purchase of disaster insurance is based upon the idea of voluntary purchase (though the size of coverage per policy may be limited).

Compulsory insurance is, however, the case in agricultural farms whereby a comprehensive package of insurance (against a range of extreme weather events) for farm buildings in addition to crops of the farmer wishes access to other avenues of governmental support. This crop insurance covers risks to a wide range of crop types to damage that was caused by flooding, hail, droughts and frosts. However, despite the legal obligation to buy insurance only ~10 % of farms are insured (~24% of insurable area)

Despite the growing insurance coverage the state can provide ad-hoc compensation to eliminate the effects of extreme weather events in terms of repairing damaged infrastructure and homes as a type of social assistance to satisfy the basic needs of living. For example, in 2010 a lump sum of 6000 PLN (~1500 EUR) was paid to those affected by a major flood. In Poland all who are affected by a natural disaster event have the possibility of compensation regardless of their insurance coverage situation. However, the current Polish risk management is characterized by a high degree of uncertainty as victims cannot rely on sufficient governmental compensation or insurance indemnities to finance a full recovery.

*Table A2.8 Attribute table for Poland*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | N/a |
| **Hazard(s) covered** | Windstorms; Floods; Hail | Windstorms; Floods; Hail | Hail; Flood; Droughts |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Bundled indemnity insurance | Indemnity insurance | Single risk crop insurance<br><br>Combined risk crop insurance |
| **Compulsory vs. voluntary** | Voluntary (required for mortgages) | Voluntary | Compulsory for farmers, insuring at least 50% of crops is required to gain access to subsidies. |
| **Damage covered** | Damage to buildings and contents | Damage to buildings and contents | Damage to crops |
| **Limit of compensation** | The upper limit for building contents is ~€3,500, while for building insurance the limit is ~€30,000. | | |
| **Individual policy deductibles** | Max 2% of insured value. | | On average 10% of the sum insured |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles | | Deductibles |
| **Market penetration rate** | Around 40-60% of households for floods.<br><br>Around 90% for windstorms. | Very low (foreign companies better insured than domestic) | About 24% to 30% of arable land (~10% of farms) |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Not risk based. Premiums tend to be driven by competition rather than technical requirements. | | Premiums are subsidized by up to 65%. |
| **Reinsurance access: Private reinsurance Public reinsurance** | Access to private reinsurance, generally for events that have return periods of at least 1/200-1/250. | | Private reinsurance of both stop-loss and quota.<br><br>Single risk (i.e. hail) are found to be easily reinsured. Multi-peril insurance faces moderate constraints. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | | | Government provides reinsurance regarding drought risks. |
| **Average annual premium** | The average insurance premium per capital is ~23-30 EUR which contains the natural disaster extension.<br><br>Historically, flood coverage has been 20% of the basic rate for fire insurance. | | Average premium of about €820 per year (6% of insured value) across all policies. |
| **Access to public disaster response fund** | Ad-hoc informal compensation is considered part of social assistance. In 2010 those affected by a flood received ~€1,500. | Ad-hoc informal compensation is considered part of social assistance. | Ad-hoc informal compensation is considered part of social assistance. |
| **Pay-out speed** | | | Pay-out aims to be within 30 days after loss has been reported. |
| **Additional comments** | High coverage rate due to link with mortgages.<br><br>Government bodies are considering the introduction of a law to make natural disaster insurance obligatory. | Monitoring is poor and thus insurance penetration rates are relatively low. | Farmers can insure part of their field, but at least 50% must be insured for at least one of the extreme weather events mentioned. |

*References: Mahul and Stutley (2008); Diaz-Caneja et al. (2009); Lamon and Penning-Rowsell, (2014); Pollner, (2012); Soliwoda, (2016); Wharton Risk Management and Decision Processes Center (2016); PIU (2017); Maccaferri et al., (2012)*

***Romania***

Romania is troubled by several natural perils, including earthquake, flood and landslides. To provide cover against these to owners of dwellings, the government has set up a compulsory insurance scheme in 2007. The scheme called "PRAC" after its Romanian initials (Romanian Program for Catastrophe insurance) is built on principles similar to several other national catastrophe insurance schemes, but with special features of its own including an important role for insurance industry and local authorities strongly involved in ensuring compliance.

On 4th November 2008 the Parliament of Romania voted the law 260, on compulsory home insurance against earthquakes, landslides and floods. This law regulates the conditions for the compulsory insurance owned by natural or legal persons, the relations between the insured person and the insurer and the rights and obligations of each party to the compulsory home insurance contract, the establishment, tasks, organization and operation of the Insurance Pool against Natural Disasters (PAID) and the provisions of PAD (Insurance policy against natural disasters).

All the stakeholders interviewed agreed that the most relevant criteria of using insurance as a tool for managing extreme weather risks is the ability of the insurance sector to absorb large losses. Thus a solid insurance system should provide the necessary measures in order to cover the most unfavourable situations which may occur at a time.

Secondly the ability to deliver fast and secure payments after a natural disaster is determined by the time of action and material resources available of the insurance companies, which are key factors in the process of restoring the previous situation.

An important attribute in risk management insurances is the insurance penetration rate. Therefore, the higher the number of insured persons, the greater is the capacity of the communities to restore the initial conditions. According to official data received from PAID Romania, the penetration rate at 31.12.2016 was approximately 20%.

This low penetration rate can pe explained through:

- From 2009 (year of PAID establishment) up to 2015, PAD was compulsory unless homeowners has a facultative insurance.
- in Romania, is a problem that is as much cultural model and the revenue model of the consumer
- public awareness system is not active enoughthere are not provided penalties for owners who do not have insurance policy PAD

The best known insurance scheme in Romania is PAD, the policy of insurance against natural disasters (a compulsory insurance policy which covers damage from floods, earthquakes or landslides on dwellings) and it was introduced in 2008 by the law 260. Regarding the affordability and availability of the insurance policy, PAID considers that PAD scheme has a low performance, because the policy is mandatory and the affordability may be a problem for the poor families. The ability to provide quick and certain compensation payments after a disaster event is subject to possible difficulties in providing property documents.

Romania is troubled by several extreme weather events such as droughts, fluvial flooding, hail, heatwaves, pluvial flooding and also windstorms. However, PAD insurance only covers damages caused by natural disaster (defined by the law 260/2008: earthquakes, landslide and flood, as natural phenomena) on dwellings.

As for the agriculture affected especially by droughts, starting 2016 the insurance company Die Österreichische Hagelversicherung România brought to Romania an insurance scheme for the farmers. For now the penetration rate is very low considering the entrance on Romanian insurance market.

***Table A2.9 Attribute table for Romania***

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | Household/Buildings | Commercial (e.g. transport, energy) | Agriculture |
| **Name, year of establishment** | PAID, 2009 | | N/a |
| **Hazard(s) covered** | Floods are insured by PAID, and storms (wind and hail) can be insured separately from private insurers. | | Spring frost; Heavy rains; Storms; Hail; Droughts |
| **Official trigger Yes /no Description?** | No | | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Bundled indemnity insurance | | Single risk crop insurance<br><br>Combined risk crop insurance |
| **Compulsory vs. voluntary** | Compulsory for homeowners to have a PAID policy, insurance companies will not provide voluntary extensions if the household does not have this coverage). | | Voluntary |
| **Damage covered** | PAID: Direct damage to buildings and contents. Neither the adjoining parts, appurtenances, facilities nor the utilities which are not structurally attached to the building where the dwelling is located or the goods inside the dwelling, shall be covered by this policy insurance.<br><br>Storms: direct damage to buildings | | Damage to crops (e.g. wheat, corn, barley, sunflowers, grape vines) |
| **Limit of compensation** | There are two potential limits:<br>€20,000 for dwellings with reinforced concrete frames, metal, or with outside walls made of burnt brick, or wood<br>€10,000 for dwellings with outside walls made of unburnt bricks or other forms of adobe. | | The insured value |
| **Individual policy deductibles** | None that can be identified | | An average of 10% insured value (15% for fruit trees) |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | None that can be identified | | A bonus-malus system, deductibles |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Market penetration rate** | PAID: 20% (high regional variance, between 9%-31%)<br><br>Storms: given that insurers will not insure households who do not hold a policy issued by PAID, the penetration rate is at most 20% (following the same regional pattern as PAID) | | Varies across crops. On average in 2005 it was ~11% of cultivated area in 2005. By 2009 it had increased to ~34% of cultivated land. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | PAID: Flat fixed rates | | A degree of risk based pricing as rates differed dependent on location and crop type. However, other companies insure at a flat rate per hectare.<br><br>However, in 2005 there was a 50% subsidy for crop insurance premiums. |
| **Reinsurance access: Private reinsurance Public reinsurance** | PAID: Risk is placed within a national pool (of 12 stakeholders, each with a share less than 15%) that can be reinsured on private markets (excess of loss). The state acts as a lender of last resort to the program in the case of overwhelming losses. In 2014-2015, total insurance capacity was valued at €450M , with retention of €1M matching with annual aggregate deductible.<br><br>Privately insured risks: private reinsurance | | Access to private reinsurance (quota-share treaties). |
| **Average annual premium** | Average property premium per capita = ~10 EUR on 2015<br><br>PAID: There are two potential policies:<br>€20 per year for €20,000 coverage<br>€10 per year for €10,000 coverage | | An average rate of 2% of the insured value (averaged across crops). About €18 per hectare |
| **Access to public disaster response fund** | None due to the presence of the governmental pool. | | |
| **Pay-out speed** | Pay-out aims to be within 60 days after receiving the claim. | | Pay-out aims to be within 15-30 days after a claim. |
| **Additional comments** | Additionally, the pool covers earthquake risk. Private insurers act as the distribution channel for PAID, they have a commission rate of 20%. | | Parts of a field can be insured.<br><br>Droughts can be insured with an additional surcharge |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | | | since 2016 due to an Austria insurance company entering the market. |

*References: Mahul and Stutley (2008); Badea (2008); CCS (2008); Diaz-Caneja et al. (2009); Radu-Neacsu (2014); Dragos and Mare (2014); Wharton Risk Management and Decision Processes Center (2016); Maccaferri et al., (2012);*

### *Spain*

Insurance cover to weather and climate-related risks is provided in Spain making a distinction between residential, commercial, industrial properties, equipment and infrastructures, and personal injury, which are covered by the so-called Extraordinary Risks Scheme, and agricultural productions, covered by the Combined Agricultural Insurance.

The Extraordinary Risks Scheme relies on the principle of compulsory extension in most policies for property damages, personal injury and business interruption. At the moment of underwriting the policy this extension has to be included and, unless stated that any or all of the extraordinary risks (hydrometeorological, geophysical and man-made) are covered by the private insurer, automatically the *Consorcio de Compensación de Seguros* (CCS) takes the coverage and indemnifies directly the policyholders in case of a claim caused by any of the extraordinary risks. For that, there is a surcharge calculated after the amount insured, depending on the line of insurance and the kind of exposure that applies at the moment of underwriting and is included in the total premium. Private insurers transfer this surcharge to CCS, retaining a 5% commission for themselves. The cornerstones of the Extraordinary Risk Scheme are the principle of compensation, being all hazards covered across Spain without geographical distinction and the principle of private-public collaboration.

CCS is a state-owned enterprise established permanently in 1954 (it was created as a provisional tool in 1941) that performs many functions at the service of the insurance sector. CCS has, nevertheless, its own legal nature and assets and receives no funding from the public budget, being surcharges and investment returns, after taxes, its only income. CCS Board of Administration is drawn equally from government officials and private insurers. Under the Extraordinary Risks Scheme are covered floods (riverine, pluvial and coastal) and strong winds exceeding 120 km/h. The average surcharge per policy issued in 2016 is ~14 EUR, which a mean insured value of ~210,000 EUR. CCS has had an average combined ratio[20] of 56% in 1981-2016. The surpluses are used to create an equalization reserve specifically for this purpose that currently has a capacity of ~EUR8bn. All other hydrometeorological risks (hail, direct damage from rain or snowfall, landslides, winds <120 km/h) are assumed directly by the private insurance companies.

The Combined Agricultural Insurance was created in 1980 and also involves a public-private partnership. *Agroseguro* is the manager of a coinsurance pool of 23 companies (in 2017) including CCS. Private companies can choose to integrate into the pool or not, as long as they are qualified for that purpose by the Spanish Insurance Supervisor Authority. Additionally, public bodies are also involved in the Administration Board of *Agroseguro.* The Combined Agricultural Insurance provides coverage against damage to crops, livestock, aquaculture and forests. Unlike with the Extraordinary Risk Scheme managed by CCS, crop insurance is, in most cases, voluntary. The Government participates actively in this branch of insurance by supporting, monitoring, and promoting the scheme, which, since its inception, has served as an instrument for managing the agricultural sector and stabilizing farm income. The scheme is subsidized by the Central State Administration under the National Agricultural Insurance Agency a subsidiary body of the Ministry of Agriculture and Fishing, Food, and the Environment and by some regional governments.

[20] Combined ratio=(operating expenses + claims paid)/Written premiums

*Table A2.10 Attribute table for Spain*

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | CCS (Consorcio de Compensación de Seguros), 1954 | CCS, 1954 | Agroseguro, 1980 |
| **Hazard(s) covered** | All extreme weather events that can be considered extraordinary: flood (pluvial, fluvial and coastal) and extreme winds (>120kph)<br><br>Non extraordinary weather events are: hail, snow weight, land mass movements and non-extreme winds (<120kph) | All extreme weather events that can be considered extraordinary: flood (pluvial, fluvial and coastal) and extreme winds (>120kph).<br><br>Non extraordinary weather events are: hail, snow weight, land mass movements, and non-extreme winds (<120kph) | Hail, flood, windstorm, drought, heatwave and other weather or climate-related risks: some pests and diseases |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Bundled combined indemnity insurance. For wind, trigger is wind speed >120 kph | Bundled combined indemnity insurance. For wind, trigger is wind speed >120 kph | Yield insurance, combined risk.<br>Index insurances (for pasture and apiculture) |
| **Compulsory vs. voluntary** | The extraordinary risk coverage is compulsorily attached to insurance policies covering a household or building, although it is not legally compulsory to insure residential properties (unless other requirements, such as those from mortgage banks) | The extraordinary risk coverage is compulsorily attached to insurance policies covering commercial property or when contracting business interruption insurance, although it is not legally compulsory to underwrite such insurance policies. | All agricultural insurance is Voluntary (except for banana and tomato produced in Canary Islands) |
| **Damage covered** | Direct damage to buildings and contents. Some extra costs are also covered: demolition, mud removal, etc. | Direct damage to buildings and contents. Some extra costs are also covered: demolition, mud removal, etc.<br>Business interruption | Crop damage<br>Livestock<br>Forestry<br>Aquaculture |
| **Limit of compensation** | Those of the original policy underwritten with the private insurer. | Those of the original policy underwritten with the private insurer. | Sum insured |
| **Individual policy deductibles** | None | 7% of claim for commercial properties. For business interruption, the deductibles applied to the original policy apply. | Differs per modality and insurance line, but averages between 10%-30% of the total insured value. |
| **Risk Reduction** | Risk reduction is the | Risk reduction is the | There are certain |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Incentive based on: Premiums Deductibles Other** | responsibility of the state. Nevertheless CCS invests on raising awareness. | responsibility of the state. Nevertheless CCS invests on raising awareness. | minimal requirements to be insured, established by the Ministry of Agriculture. There is also a bonus-malus system. Finally, there are discounts for preventive measures (hail, frost and others). |
| **Market penetration rate** | 75%-100% | 75%-100% (for property and contents insurance) | 27% of Agricultural production was insured in 2015, varying greatly among crop types. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Flat rate premiums. 0.08 per mille of the insured value | Flat rate premiums of 0.12 per mille of the insured value in offices and shops, 0.21 per mille for industrial risks.<br><br>For business interruption for a surcharge of 0.25 per mille of the insured value is applied. | Between 2000 and 2015 premiums averaged 4.9%of total insured value. 53% of the premium is subsidized.<br><br>There was an element of risk zoning employed. |
| **Reinsurance access: Private reinsurance Public reinsurance** | CCS does not currently transfer its risk to the private reinsurance market (although it could if deemed necessary)<br><br>CCS has an equalization reserve for these purposes. | CCS does not currently transfer its risk to the private reinsurance market (although it could if deemed necessary).<br><br>CCS has an equalization reserve for these purposes. | A mixture of reinsurance channels. The CCS provides reinsurance distinguishing between experimental (i.e. systemic risks as drought and frost) and viable lines (i.e. hail). CCS is the only reinsurer for experimental lines with 75% of the share of commercial premiums. Private reinsurers tops up part of the reinsurance for viable lines . |
| **Average annual premium** | Average property premium per capita in 2015 = ~150 EUR<br><br>Mean of 13.78€ surcharge for residential property (2015); mean insured value 172,363€. | Mean of 34.46€ for commercial property (2015); mean insured value ~200,000€. Mean of 414€ for industries; mean insured value ~€2 million. | 4.9% of total insured value (2000-2015) |
| **Pay-out speed** | The target is to pay 85%-90% of claims within 60 days after a catastrophic event. | The target is to pay 85%-90% of claims within 60 days after a catastrophic event. | Within 60 days from the end of harvest (average of 40 days)<br>Within 40 days for livestock. |
| **Additional comments** | The Extraordinary Risk Scheme managed by CCS provides also coverage against personal injury. Therefore life and accident insurance policies are also included in the scheme and this coverage is valid even for extraordinary events (as defined) affecting Spanish residents and policyholders | | The farmer must insure all agricultural productions (crops, livestock, forest production, aquaculture production) of the same |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | outside Spain.<br>Motor cars are also included in the Scheme. | | type. |

*References: Diaz-Caneja et al. (2009); Swiss Re (2015); Wharton Risk Management and Decision Processes Center (2016); CCS (2016); Najera (2014)*

### *Sweden*

Sweden relies on a private insurance market with little government interference to provide extreme weather event insurance. The Swedish insurance industry currently offers good cover for all climate related claims. For instance, cover against flooding is included in ordinary householder and home owner policies, which is relatively unusual. Further, the penetration rate is high with one of the reasons for this being that it is compulsory for both household and commercial mortgages.

Insurance companies in Sweden have so far been able to give good protection for all climate related events through the basic insurance products. However, when climate related events increase in its frequency and intensity, this might not be possible. The basic criteria for insurance schemes, that the event is sudden and unpredictable, will no longer be met and climate adaptation and risk reduction measures at all levels in society are therefore fundamental in order to ensure affordability and availability of insurance in Sweden.

***Table A2.11 Attribute table for Sweden***

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | N/a | N/a | N/a |
| **Hazard(s) covered** | Floods; Storms | Floods; Storms | Hail; Droughts |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Private bundled indemnity insurance | Private bundled indemnity insurance | Private indemnity insurance (hail and droughts may be combined) |
| **Compulsory vs. voluntary** | Voluntary (required for mortgages) | Voluntary (required for mortgages) | Voluntary |
| **Damage covered** | Damage to property and contents | Damage to property and contents | Hail: damage to crops<br>Droughts: replanting costs |
| **Limit of compensation** | In theory none: average coverage in 2010 was ~€55,000. | | Hail: The limit is based on the average value (based on average prices)<br>Droughts: The limit is based on the average cost of replanting per hectare. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Individual policy deductibles** | 10% of claim (bounded by ~€320-€1,100) | | Deductibles are dependent on the crop and range from between 0%-15% of insured value. |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles | Deductibles | Deductibles |
| **Market penetration rate** | >95% of households | >75% of business property for flooding | ~60% of insurable crops (~ same percentage of farms) |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Limited risk differentiation | Limited risk differentiation | Np premium subsidies |
| **Reinsurance access: Private reinsurance Public reinsurance** | Private reinsurance | Private reinsurance | Private reinsurance |
| **Average annual premium** | Average premium ~€1,300 (own calculations from data) | | |
| **Access to public disaster response fund** | No | No | No |
| **Pay-out speed** | Within one month | Within one month | |
| **Additional comments** | | | Limited competition in terms of the number of companies offering crop insurance. |

*References: Diaz-Caneja et al. (2009); Brandstrand and Wester (2014); EC (2014); Svensk Forsakring (2016); UN (2007); Maccaferri et al., (2012); Svensk Forsakring (2013);*

### *The United Kingdom*

The insurance market is free from government interference outside of general regulation (There have only been very rare cases of limited ad-hoc government compensation after a disaster). Therefore, the insurance market is predominantly driven by competition between private insurance companies, whereby premiums are generally risked based. However, many banks or mortgage providers require that the property have full insurance coverage in order for the loan to be provided. Therefore, this informal mortgage requirement creates an informal purchase requirement across both high and low risk policyholders that aids in the overall affordability of general insurance coverage. There are many companies that are involved in the general property insurance market.

The prominent problem facing the UK insurance industry in terms of extreme weather events has been flooding. In the insurance industry and the UK struck a gentleman's agreement that insurance coverage against flooding was to be provided at affordable rates on the condition of continued state investment in flood defences. However, in the year 2000 this informal agreement was formalised in the Statement of Principles, which stated that homeowners insurance would cover flooding if the property had an annual chance of being flood of 1.3% or smaller. The statement was originally planned to end in 2007 but was extended while discussions for Flood Re were underway, which formally began in 2016 (for more about Flood Re, see below).

***Table A2.12 Attribute table for the United Kingdom***

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| **Name, year of establishment** | Flood Re for high risk flood risk properties established in 2016 | N/a | N/a |
| **Hazard(s) covered** | Floods and Storms | Floods; Storms | Hail |
| **Official trigger Yes /no Description?** | No | No | No |
| **Type of insurance, e.g. bundled, parametric triggers** | Private bundled indemnity insurance | Private indemnity insurance | Private indemnity insurance |
| **Compulsory vs. voluntary** | Voluntary (required for mortgages, hence bundled into property insurance) | Voluntary (required for mortgages, hence bundled into property insurance) | Voluntary |
| **Damage covered** | Direct damage to buildings and contents | Direct damage to buildings and contents<br><br>Business interruption | Damage to crops |
| **Limit of compensation** | In theory none other than the agreed upon insured value | In theory none other than the agreed upon insured value | |
| **Individual policy deductibles** | Very policy dependent. In relatively low risk areas the excess ranges between 115 EUR and 290 EUR.<br><br>Flooding: in higher risk areas before Flood Re could be between ~3000 and 6000 EUR and ), but were only about £50 | Very policy dependent | For most crops none, but for fruit there is a co-insurance payment of 10%. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | (in low risk areas). However, a policy seceded to Flood Re has an excess of ~290 EUR. | | |
| **Risk Reduction Incentive based on: Premiums Deductibles Other** | Deductibles; examples of minimal risk management measures in place in order to gain affordable insurance. Very few incentives for additional risk reduction past any minimal required standard | Deductibles; examples of minimal risk management measures in place in order to gain affordable insurance. Very few incentives for additional risk reduction past any minimal required standard | Deductibles |
| **Market penetration rate** | 75%-95% of households | | Hail coverage corresponds to about 7% of total cultivated area. |
| **Premium Setting rule, e.g. risk based, flat, fixed percentage of insured value?** | Risk based for the most part (especially in high risk areas), though there appears to be little variation for flood risk on the whole. Low flood risk households have a ~12 EUR surcharge on their premiums, while very high risk households have their flood risk premiums capped based on their property's property tax value. | | Fixed percentage of insured values as there might not be sophisticated methods to determine rates. However, rates can differ across crops and in quite broad regional zones. |
| **Reinsurance access: Private reinsurance Public reinsurance** | Private reinsurance<br><br>Flood Re is a pool for high flood risk households (that can be privately reinsured) with the possibility of placing a levee on insurers to make up for shortfalls. | Private reinsurance | Private reinsurance |
| **Average annual premium** | Average property premium per capita in 2015 = ~275 EUR<br><br>Combined building and contents insurance of about 420-450 EUR (in 2012)for general household insurance. A DEFRA study noted the difficulty in assessing premiums due the presence of deductibles. However, premiums overall may have fallen to ~333 EUR in 2013<br><br>An average rate of about 3 EUR per ~1,200 EUR.<br><br>Flood Re: premiums seceded to Flood Re range from ~243 EUR to ~1400 EUR based on council tax bounds (for combined property and contents insurance). The most common premium is expected to be | | Most crops are at ~1% of the total insured value. For fruit crops it is ~5.5% of the insured value.<br><br>An average premium of about €30 per hectare. |

| ATTRIBUTE | SECTOR | | |
|---|---|---|---|
| | **Household/Buildings** | **Commercial** | **Agriculture (crop)** |
| | ~320 EUR. | | |
| **Access to public disaster response fund** | No | No | No |
| **Pay-out speed** | | | Aims to be paid after harvest. |
| **Additional comments** | The ABI provides information ways that policyholders can limit damage in the case of extreme weather events.<br><br>Flood Re will only provide insurance for buildings that were in place before 01/01/2009. Moreover, Flood Re will be reviewed every 5 years | | Whole fields must be insured; all crops of the same type must be insured. |

*References: Lamond and Proverbs (2008); NIA (2008); Lamond et al., (2009a, 2009b); Diaz-Caneja et al. (2009); Penning-Rowsell and Pardoe (2012); Maccaferri et al., (2012); Surminski and Eldridge (2015); Wharton Risk Management and Decision Processes Center (2016)*

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**APPENDIX 3**
**MCA SCORING**

## Household MCA scoring

All these criteria are considered holistically across the various disasters. While it is true that some nuance across disasters is lost due to the fact that some extreme weather events are highly localised (such as fluvial flooding) for the most part across Europe we have insurance being provided as a bundle of risks and not as a singular risk, where I think that looking at separate disasters is more relevant.

*Criterion 1: Insurance penetration rate*

This is measured as the percentage of households that have coverage against the set of relevant extreme weather events (i.e. flooding (fluvial, pluvial, and coastal), hail, and windstorm) for this sector. The three types of flooding were merged into a single indicator such that coastal countries, e.g. Bulgaria, can be fairly compared to landlocked countries, e.g. Austria.

This should be judged as the average penetration rate across the extreme weather events. For example Germany has a penetration rate of 95% for hail, 95% for windstorm, and 40% for flooding; providing a rate of ~70%. The UK on the other hand is presented as a range between 75-95% and therefore the mid-point should be used (i.e. 85%).

We focus on the percentage of households with an insurance policy because the amount of coverage provided is not consistency across the various case studies. For the most part the only information we have is 'up to total insured value'. Therefore, this should be made clear that while important is not how we are looking at it.

The 'holistic' penetration rate is then compared to Table A3.1 and is awarded the required points.

***Table A3.1 Scoring metric for criterion one***

| 4 points | 3 points | 2 points | 1 point | 0 points |
|---|---|---|---|---|
| [81,100] | [61,80] | [41,60] | [21,40] | [0,20] |

*Criterion 2: Risk signalling ability*

This criterion measures the 'holistic' ability of insurance market structures to act as a signal of risk or risk reduction potential. Each element that a scheme displays can be awarded with the associated points. For example a country that employs large deductibles (2 points) and risk based premiums (2 points) would score 4 points, while a market with small deductibles (1 point) and flat rate premiums (0 points) would only score 1 point.

The only binary elements are small or large deductibles. In order to judge the size of deductibles the mid-point of the range of deductibles should used (i.e. a deductible for windstorms of 500 EUR and 5000 EUR for floods would have a mid-point of 2750 EUR scoring 2 points).

**Table A3.2 Scoring metric for criterion two**

| 2 points | 1 point | 0 points |
|---|---|---|
| • Large deductibles (i.e. larger than 2000 EUR)<br>• Premium discounts<br>• Required vulnerability standards<br>• Risk based premiums | • Small deductibles (i.e. smaller than 2000 EUR but larger than 0 EUR )<br>• Awareness campaign | • No risk signalling |

*Criterion 3: Ability to absorb large losses*

This criterion judges the ability of the sector to absorb large losses holistically across the various extreme weather events. While it these factors provide insurers with the ability to diversity their sources of capital such that they can better perform in the case of large scale events. However, this must be tempered with the knowledge that the Solvency II regulations require firms to be able to survive a 1/200yr loss event. Moreover, there may be concern that the presence of public mechanism creates a type of charity hazard whereby private agents become more lax with regards to when they receive government aid. However, while important consistent information across the countries could not be collected. Moreover, we do not make a judgement about a government's ability to provide such a grantee as this can be quite time dependent (i.e. in the middle of a recession vs. an economic boom).

The elements in Table 3 are often mutually exclusive of one another in the 2 point and 1 point columns. Therefore, a country either has access to private reinsurance for all risks (2 points) or it does not (1 point).

For example, Denmark has access to private sector reinsurance for most risks (1 point), with a disaster wide pool for coastal flooding (2 points) with a limited state grantee (2 points) for a total of 5 points. France on the other hand has access to private reinsurance for some risks (1 point) while it has access to public insurance for others (1 point) with an unlimited state grantee (3 points) for a total of 5 points).

**Table A3.3 scoring metric for criterion three**

| 3 points | 2 points | 1 point |
|---|---|---|
| • Unlimited State grantee for *NatCat* losses | • Access to private reinsurance for all risks<br>• Access to sector/disaster wide pool for all risks<br>• Access to public sector Reinsurance for all risks<br>• limited State grantee for *NatCat* losses | • Access to private reinsurance for some risks<br>• Access to sector/disaster wide pool for some risks<br>• Access to public sector Reinsurance for some risks |

*Criterion 4: Availability and affordability*

Unlike the other indicators provided above there are two sub-elements for this criterion: 4a – affordability and 4b availability. The final score for a market on criterion 4 is the sum of the score for 4a and 4b.

*4a Affordability*

This indicator is judged by the percentage of the population that would find the presented insurance premium 'unaffordable' as defined in Hudson et al. (2016). This is a residual income definition, whereby a household finds insurance unaffordable if the premium is larger than (income-poverty line). The poverty line is defined as 60% of national median income. This focuses on the low-income households and the burden that insurance premiums place on them.

One of the common features of the insurance markets across Europe is that it is hard to distinguish which part of the premium comes from what particular extreme weather event. Therefore, we should not distinguish the separate premiums. It must also be acknowledged that some premiums for localised events grow quite rapidly in higher risk areas (i.e. storm premiums might be fairly constant across a country, while flood risk premiums could strongly vary by neighbourhood).

Therefore, the premium to be used is the average property premiums per capita in 2015. This forms the minimum percentage of the population that would find the premiums unaffordable. This is with the caveat that in more hazardous areas or less well protected places the premiums may be higher and more unaffordable, but these is likely to occur in very specific areas which is not the correct level of study for this application.

For example, the average property premium per capita in Hungary in 2015 was ~100 EUR. Therefore, at least 16% of the population would find such premiums unaffordable scoring Hungary 1 point on this sub-criterion

***Table A3.4 scoring metric for criterion four a***

| Indicator | 4 points | 3 points | 2 points | 1 point | 0 points |
|---|---|---|---|---|---|
| The percentage of the population finding insurance unaffordable | [0,5] | [6,10] | [11,15] | [16,20] | [>=21] |

*4b Availability*

This is judged as the number of extreme weather events that can be insured against out of the following events:

1) Flooding (at least one of the following: pluvial, fluvial or coastal) – there is no real distinction made between the different types of flooding as landlocked countries cannot suffer from coastal flooding and as such the comparison would be unfair. Once again, the impression of these events is holistically viewed
2) Hail
3) Windstorm

Care must be taken where it is known that exclusions are enforced. For example, in Hungary one can buy a bundle that covers windstorm, hail, cloudburst and fluvial flooding. However, in high flood risk areas there are cases of exclusions (since the removal of the governmental insurance scheme) and so universal coverage is not possible. Hence, in this case Hungary would score 2 points (1 for windstorms and 1 for hail).

*Table A3.5 scoring metric for criterion four b*

| Indicator | 1 point |
|---|---|
| The number of extreme weather events that can be insured against | 1 point per extreme weather disaster |

Overall on criterion 4, Hungary has scored 1 point on criterion 4a and 2 points on criterion 4b. Therefore, the total score for Hungary on criterion 4 would be 3 points.

*Criterion 5: Quick and certain compensation payments*

Of the two elements of this criterion, for the household sector information of the quickness of compensation payments was inconsistently available for all markets as it tended to be very company specific and dependent on when policyholders started the indemnity process.

Therefore, for the household sector the focus is on the certainty of receiving compensation.

*Table A3.6 scoring metric for criterion five*

| Indicator | 2 points | 1 point | 0 points |
|---|---|---|---|
| Certainty | • No ad-hoc government compensation is possible. There are only formal mechanisms for risk transfer with clear rules | • Limited private sector insurance coverage and ad-hoc government compensation<br>• Specialist loss adjusters are used to assess and process claims. | • Complete reliance on ad-hoc government compensation |

The scoring metric presented in Table 6 focus on the clarity at which policyholders, or those affected, more generally can expect regarding their compensation. It can be that a household knows that once they have a value for their loss the insurer will provide a pre-agreed upon amount providing a great deal of certainty, while another area maybe reliant on the will of the government at the time to provide compensation.

For example, Romania has no scheme in place for ad-hoc government compensation as this role has been transferred to the PAD pool (2 points) with specialist loss adjusters (1 point) for a total score of 3 points. While Bulgaria on the other hand has limited insurance coverage and ad-hoc compensation (1 point).

## Agriculture extreme weather insurance MCA scoring

All these criteria are considered holistically across the various disasters. While it is true that some nuance across disasters is lost due to the fact that some extreme weather events are highly localised (such as fluvial flooding) for the most part across Europe we have insurance being provided as a bundle of risks and not as a singular risk, where I think that looking at separate disasters is more relevant. In this we focus on crop insurance as the most consistent information was provided.

*Criterion 1: Insurance penetration rate*

This is measured as the percentage of farms that have coverage against the set of relevant extreme weather events (i.e. flooding (fluvial, pluvial, and coastal), hail, windstorm, droughts) for this sector. This should be judged as the average penetration rate across the extreme weather events in terms of the percentage of arable land that is insured. However, it must be noted that not all crops are insured equally and where a distinction is made the mid-point should be used.

For example Germany has a penetration rate of 60% of farm land for hail, and little for other perils. However, as hail is the most commonly insured event across Europe we do not make the distinction between the extreme weather events. Therefore in this case Germany would score 2 points, while Italy with 9% would score 0. Moreover, as was mentioned during the focus group crops are very sensitive at differing times of the year so most farmers are willing to take a gamble when it comes to indemnity/yield losses.

We focus on the percentage of farms with an insurance policy because the amount of coverage provided is not consistency across the various case studies. For the most part the only information we have is 'up to total insured value'. Therefore, this should be made clear that while important is not how we are looking at it.

The 'holistic' penetration rate is then compared to Table 1 and is awarded the required points.

***Table A3.7 Scoring metric for criterion one***

| 4 points | 3 points | 2 points | 1 point | 0 points |
|---|---|---|---|---|
| [40+] | [31,40] | [21,30] | [11,20] | [0,10] |

*Criterion 2: Risk signalling ability*

This criterion measures the 'holistic' ability of insurance market structures to act as a signal of risk or risk reduction potential. Each element that a scheme displays can be awarded with the associated points. For example a country that employs large deductibles (2 points) and risk based premiums (2 points) would score 4 points, while a market with small deductibles (1 point) and flat rate premiums (0 points) would only score 1 point.

The only binary elements are small or large deductibles. In order to judge the size of deductibles the mid-point of the range of deductibles should used (i.e. a deductible for windstorms of 30% and 10% EUR for floods would have a mid-point of 20% scoring 1 points).

A note to be concerned with is that in the agricultural insurance market premiums are often subsided by the state. The presence of such subsidies limits or prevents the ability of the insurance market to provide a full signal of risk as the price signal becomes muddled. To this end the presence of premium subsidies prevents the market from displaying risk based premiums.

***Table A3.8 scoring metric for criterion two***

| 2 points | 1 point | 0 points |
|---|---|---|
| • Large deductibles (i.e. a loss of 30% or more)<br>• Premium discounts<br>• Required vulnerability standards<br>• Risk based premiums<br>• Bonus-malus | • Small deductibles (i.e. a loss less than 30% )<br>• Awareness campaign | • No risk signalling |

*Criterion 3: Ability to absorb large losses*

This criterion judges the ability of the sector to absorb large losses holistically across the various extreme weather events. While it these factors provide insurers with the ability to diversity their sources of capital such that they can better perform in the case of large scale events. However, this must be tempered with the knowledge that the Solvency II regulations require firms to be able to survive a 1/200yr loss event. Moreover, there may be concern that the presence of public mechanism creates a type of charity hazard whereby private agents become more lax with regards to when they receive government aid. However, while important consistent information across the countries could not be collected. Moreover, we do not make a judgement about a government's ability to provide such a grantee as this can be quite time dependent (i.e. in the middle of a recession vs. an economic boom).

The elements in Table 3 are often mutually exclusive of one another in the 2 point and 1 point columns. Therefore, a country either has access to private reinsurance for all risks (2 points) or it does not (1 point).

***Table A3.9 scoring metric for criterion three***

| 3 points | 2 points | 1 point |
|---|---|---|
| • Unlimited State grantee for *NatCat* losses | • Access to private reinsurance for all risks<br>• Access to sector/disaster wide pool for all risks<br>• Access to public sector Reinsurance for all risks<br>• limited State grantee for *NatCat* losses | • Access to private reinsurance for some risks<br>• Access to sector/disaster wide pool for some risks<br>• Access to public sector Reinsurance for some risks |

*Criterion 4: Availability and affordability*

Unlike the other indicators provided above there are two sub-elements for this criterion: 4a – affordability and 4b availability. The final score for a market on criterion 4 is the sum of the score for 4a and 4b.

*4a Affordability*

This indicator is simply judged as the premium as a percentage of the insured value. This is a different concept to that employed regarding household insurance as crop insurance is closer to a commercial protection policy.

The premium as a percentage of the insured value should be treated as inclusive of any subsidy that is provided. For example, in the UK the premium was ~1% of the insurable value with no subsidy while in Spain it was ~5% with a ~50% subsidy or a net premium of 2.5% of insurable value. In this case the UK would score 4 points while Spain would score 2 points.

Where multiple premiums are presented for varying events the mid-point of the estimates should be used.

***Table A3.10 scoring metric for criterion four a***

| Indicator | 4 points | 3 points | 2 points | 1 point | 0 points |
|---|---|---|---|---|---|
| The premium as a percentage of the total insured value | [0,1] | (1,2] | (2,4] | (4,6] | >=6 |

*4b Availability*

This is judged as the number of extreme weather events that can be insured against out of the following events:

1) Flooding (at least one of the following: pluvial, fluvial or coastal) – there is no real distinction made between the different types of flooding as landlocked countries cannot suffer from coastal flooding and as such the comparison would be unfair. Once again, the impression of these events is holistically viewed
2) Hail
3) Windstorm
4) Droughts/heatwaves

Not all extreme weather events are equally pressing across Europe, however, we treat all events equally in that climate change or random chance can change the risk profile facing a farmer.

***Table A3.11 scoring metric for criterion four b***

| Indicator | 1 point |
|---|---|
| The number of extreme weather events that can be insured against | 1 point per extreme weather disaster |

For example in the UK only hail crop insurance was found and would therefore score 1 point while in Spain coverage is provided against flooding, hail windstorms, droughts and heatwaves and would therefore score 4 points.

The total score on the criterion is the sum of the separate scores for 4a and 4b. Therefore, in the above examples the UK would score a total of 5 points (4 from 4a and 1 from 4b) while Spain would score 6 points (2 from 4a and 4 from 4b)

*Criterion 5: Quick and certain compensation payments*

*5a Certainty of compensation*

This criterion follows the same logic as with the household sector.

***Table A3.12 scoring metric for criterion five a***

| Indicator | 2 points | 1 point | 0 points |
|---|---|---|---|
| Certainty | • No ad-hoc government compensation is possible. There are only formal mechanisms for risk transfer with clear rules | • Limited private sector insurance coverage and ad-hoc government compensation<br>• Specialist loss adjusters are used to assess and process claims. | • Complete reliance on ad-hoc government compensation |

*5b Quickness of compensation*

The faster and clearer a compensation payment is provided the points a market will score.

***Table A3.13 scoring metric for criterion five b***

| Indicator | 4 points | 3 points | 2 points | 1 point | 0 points |
|---|---|---|---|---|---|
| Speed | Up to 15 days | Up to 30 days | Up to 60 days | Up to 90 days | Only viable information was that the claim was to be settled after harvest |

**Standardisation process**

Both the household and agricultural sector MCA studies use the same process to standardise scores before they are aggregated. The first one based on a continuous ranking (Equation (3)) and the second on a relative ranking (Equation (4)).

$$\mathrm{MCA}_{c,,i} = \frac{\left(\mathrm{MCA}_{c,i}\right)^{raw\ score}}{Max\ points\ possible\ for\ criterion\ c} \qquad (3)$$

$$\mathrm{MCA}_{c,,i} = \frac{\left(\mathrm{MCA}_{c,i}\right)^{raw\ score} - \left(\mathrm{MCA}_{c,min}\right)^{raw\ score}}{\left(\mathrm{MCA}_{c,max}\right)^{raw\ score} - \left(\mathrm{MCA}_{c,min}\right)^{raw\ score}} \qquad (4)$$

The continuous ranking system highlights how well a case study performs on a criterion relative to the best possible outcome, while the relative ranking system ranks case studies based on how well they perform compared to one another. So while the relative ranking system may identify 'best practice' insurance schemes relative to other countries' schemes, the continuous ranking system shows how close (or far off) this best practice scheme is from the 'ideal' scheme. Taken together the two systems can more robustly highlight which cases score most highly.

**APPENDIX 4**
**STAKEHOLDER CONSULTATION**

***Table A4.1: Categories of relevant stakeholders***


***Table A4.2: Stakeholders consulted throughout the process***

| COUNTRY | ORGANISATION |
|---|---|
| Austria | GRAWE |
| Austria | Verband der Versicherungsunternehmen Österreichs |
| Bulgaria | Bulgarian Insurance Association |
| Denmark | Danish Technical University |
| Denmark | Forsikring og Pension Danmark |
| Denmark | Danish Coastal Authority |
| Denmark | Danish Storm Council |
| Denmark | City of Copenhagen |
| EU Wide | Insurance Europe |
| France | Mission Risques Naturels |
| France | Ecole Polytechnique |
| France | French Federation of Insurance Companies (FSSA) |
| France | Scor |
| France | Caisse Central de Reassurance |
| France | CEPRI |
| France | Autorité de Contrôle Prudentiel |
| Germany | B2B Protect GmbH |
| Germany | German Insurance Association (GDV) |
| Germany | Hannover Re |
| Germany | Allianz |
| Germany | Munich Re |
| Italy | Italian National Association of Insurance Companies (ANIA) |
| Italy | Confagri |
| Italy | Coldiretti |
| Italy | FEEM |
| Multi | ClimateWise |
| Multi | FM Global |
| Multi | ICLEI |

| COUNTRY | ORGANISATION |
|---|---|
| Multi | ICMIF |
| Multi | Insurance Development Forum (IDF) |
| Multi | CCRE-CEMR |
| Multi | Afore Consulting |
| Multi | ARCTIK |
| Multi | Milieu Ltd |
| Multi | Climate Kic |
| Multi | OECD |
| Multi | UNEP |
| Multi | ACT Alliance EU |
| Multi | C40 |
| Multi | CEMR/PLATFORMA |
| Multi | Eurocities |
| Multi | FUEDI/Crawford |
| Multi | Copa-Cogeca (European Farmers European Agri-Cooperatives) |
| Multi | Geneva Association |
| Netherlands | Dutch Association of Insurers |
| Netherlands | Achmea |
| Netherlands | Maastricht University |
| Norway | Finance Norway |
| Norway | Norwegian Environment Agency |
| Romania | Pool of Insurance Companies Against Disasters (PAID) |
| Romania | National Association of Insurance and Reinsurance Companies in Romania (UNSAR) |
| Romania | General Inspectorate for Emergency Situations (IGSU) |
| Spain | State Entity for Agricultural Insurance (ENESA) |
| Spain | Spanish Insurance Consortium |
| Spain | Association of Spanish Insurers (UNESPA) |
| Spain | Agroseguros |
| Sweden | AIG Europe |
| Sweden | Trygg Hansa |
| Sweden | Länsförsäkringar |
| Sweden | If Skadeforsakring |
| Sweden | Insurance Sweden |
| Sweden | SMHI |
| Sweden | Stockholm Environment Institute |
| Switzerland | Zurich Insurance |
| Switzerland | Swiss Re |
| United Kingdom | Marsh&McLennan Companies |
| United Kingdom | Guy Carpenter |
| United Kingdom | Flood Re |
| United Kingdom | London School of Economics |
| United Kingdom | Guy Carpenter & Company Ltd |

*Table A4.3: Stakeholder responses to questionnaire*

| COUNTRY | POSITIVE RESPONSE |
|---|---|
| Bulgaria | 1 private sector insurer (DZI) |
| Romania | 1 insurer (PAID)<br>1 academic (INHGA) |
| Hungary | 1 governmental agency (AKI) |
| Poland | |
| Sweden | Insurance Sweden<br>4 private insurers (Länsförsäkringar AB, If P&C insurance Ltd, AIG Europe Limited, Trygg Hansa) |
| Denmark | Danish Insurance Association<br>Danish Storm Council |
| France | 2 academic (University of Montpellier 3 Paul Valéry, Ecole Polytechnique)<br>1 public insurer (CCR)<br>1 public body (MRN) |
| The UK | 1 Charity (national flood forum) |
| Germany | German Insurance Association |
| Austria | Austrian Insurance Association<br>Austrian Hail Insurance Company |
| Italy | Italian insurance association |
| Spain | 1 public insurer (CCS)<br>1 academic (FEEM) |
| EU Wide | OECD<br>Researcher (wanted anonymity)<br>Insurance Europe<br>FERMA |

In all countries at least three organisations have been contacted, and usually many more. Gaps in certain member states and/or type of stakeholder reflect a lack of responsiveness to our solicitations.

*Table A4.4: Stakeholders who contributed to the focus groups and the final event*

| COUNTRY | ORGANISATION |
|---|---|
| Austria | GRAWE / VVO |
| Denmark | City of Copenhagen |
| Denmark | Forsikring og Pension |
| EU Wide | Insurance Europe |
| EU Wide | ICLEI - Local Government for Sustainability |
| EU Wide | OECD |
| France | Mission Risques Naturels |
| Germany | Allianz |
| Germany | Munich RE |
| Germany | MCII |
| Italy | Coldiretti |
| Norway | Finance Norway |
| Spain | ENESA |
| Switzerland | Swiss Re |
| Switzerland | Zurich Insurance |
| UK | London School of Economics |
| UK | ClimateWise |

*Table A4.5 Stakeholder assessment and rational for the importance of the studied extreme weather events*

| ATTRIBUTE | Spain | Sweden | Germany | EU wide | Austria | The United Kingdom | Hungary (agriculture) |
|---|---|---|---|---|---|---|---|
| **Coastal flooding / storm surges** | Large cities away from the coast. Infrastructures suffice to cope with this peril. Only the Spanish coastline prevents more damages by coastal flooding combined with large cities away from the ghost. Sea level could increase this risk in the medium-term. | Not an important factor in Germany. Communities invest in climate proofing the dikes, not insurance | In temperate climates, more frequent nuisance coastal flooding linked to sea-level rise will challenge the insurability of coastal areas. | With sea level rise damages will increase during the century along the south coast of Sweden | Austria is a landlocked country | Projections re that coastal risk will increase | |
| **Droughts** | Drought damages in Spain are important (and expected to be even more important in the future), but quite limited to agriculture. Incremental losses in irrigated agriculture. | Not directly insured, but indirect insurance (business interruption) possible. | | The eastern parts of Sweden is already hit by drought, which effects the drinking water. Not so large effect on insurance as it for those living there. | Slight increase expected | | |
| **Fluvial flooding** | Associated with flash floods, is important, particularly in Northern Spain. | Upgraded prevention measures will safeguard those along rivers. | The impact of climate change on vary across regions. As a result, there is not the same level of overall risk increase found for pluvial and coastal flooding. unlikely to be a significant increase in the area susceptible to fluvial flooding in the context of climate change. | Periods of long rain will causes lakes and rivers to flood. These periods will increase. | Better safeguards and risk-prevention work | Major flood defence schemes will address much of this, even if the risks increase. Risk could be reduce significantly through appropriate planning. | |
| **Hail** | 1-2 most relevant | The more energy there | | Sweden hasn´t | Increase in number | | |

| ATTRIBUTE | Spain | Sweden | Germany | EU wide | Austria | The United Kingdom | Hungary (agriculture) |
|---|---|---|---|---|---|---|---|
| | impact in agriculture | is in the atmosphere (due to rise of the mean global temperature), the more likely torrential rain and hail phenomena are. | | seen the heavy hails that has hit Europe yet, but the climate change will probably change that. | and intensity of events | | |
| **Heatwaves** | Heat wave damages for in livestock.<br><br>Heatwaves are expected to increase in the future.<br><br>It might be possible to consider including personal damages from heat waves in the future (currently excluded). | Not insured in property insurance (-> life insurance). | | Not a large insurance problem. Mainly for health care. But forest fire can occur when it is a heat wave | | | |
| **Pluvial flooding** | Flood losses (pluvial, fluvial and coastal together) add up to 75% of all natural disaster compensations paid by CCS. | Most underestimated risk. | One of the most significant challenges for flood schemes as the expected increase in intensity of pluvial rain will expand the area that is susceptible to flooding to areas with no history of flooding.<br>That said, the broader susceptibility to flood damage should reduce the adverse selection problems inherent in flood insurance (i.e. where only high-risk policyholders | Heavy rains increases due to climate change and can hit all over Sweden. We have seen an increase in events and costs. | Increase of flash floods | Pluvial flooding is probably rather under recorded and will increase, particularly through intense rainfall events. Major defence schemes will not be available for many areas and often small numbers of properties will be affected in each area. Lots of small scale interventions are required alongside rigorous planning policies. The result is that real risk may well increase. | |

| ATTRIBUTE | Spain | Sweden | Germany | EU wide | Austria | The United Kingdom | Hungary (agriculture) |
|---|---|---|---|---|---|---|---|
| | | | purchase insurance). | | | | |
| **Windstorms** | Occasional losses of life could make it rank higher. | Good building codes, well prepared property in Germany.<br><br>Although with less frequency than in other parts of Europe, windstorms cause significant losses in Spain, particularly in its Northernmost third and in mountainous areas. Wind damages add up to 18% of all natural disaster compensations paid by CCS under ERIS. | the evidence on the impact of climate change on windstorms is very mixed (i.e. only some studies expect a likely increase in frequency and/or intensity). | Storms do have most effects on property and forest. However, storms is not Climate driven in Sweden | Climate warming causes a general increase in storm events | | |
| **Trends in risk between 1990 and 2015** | Losses in agriculture have increased noticeably, especially those related to droughts and heatwaves. The former are related to governance and exposure as compared to climate change. It is expected that this will worsen.<br>The loses paid by CCS have doubled between 1990 and 2015, but the number of policies covered has also increased 3.3 times in the same period.<br>A steady increase in weather-related losses, but this is more due to | The general concerns is that there has been a moderate increase in extreme weather related losses.<br><br>The stakeholders expect that heavy rain and sea level rise will be the main problem in the near term. Though there is a large variability in between years. | Very difficult to answer. The amount of losses is mostly affected by higher sums insured and inflation at the same time as improved protection strategies. Agrees with the overall scientific consensus. In order to ensure controllable increase of losses in those countries, which upgrade their prevention measures. Furthermore, adapt the building codes where necessary | Most sources suggest that losses have increased over time (by a multiple of 3x to 10x for flooding, for example, since 1970) although the relative contribution of asset accumulation compared to changes in the frequency or intensity of disasters is debatable. | About 5%-7% increase in losses annually. An approximately 10% increase annually is expected | As people buy more goods, costs will increase. Of course, the financial costs to people are only one element of the impact of flooding. Research on health, for example, is showing that flooding incidents have a far greater impact than previously thought. | Accurate values are not known. The variability of yield fluctuations may have approx. doubled. It is expected to increase. |

| ATTRIBUTE | Spain | Sweden | Germany | EU wide | Austria | The United Kingdom | Hungary (agriculture) |
|---|---|---|---|---|---|---|---|
| | increased coverage and the increased insured values of the properties rather than to an increase of the levels of hazard, at least in a short-medium term. | | and invest in public risk awareness campaigns. | | | | |
| **Trends in Premiums between 1990-2015** | Premiums have altered little in terms of agricultural insurance. The general CCS insurance has been mostly unchanged. There is no major change expected. | Due to extreme weather insurance being covered by a general insurance policy, premiums have remained quite stable. Keeping insurance as a general product is expected to keep premiums low. A lack of adaption may lead to a withdrawal of insurance or a more rapid increase in premiums. | Nationwide extreme weather insurance is available since 1994. Products and actuarial analysis took a few years. Products came to market widely at the end of the 1990s. The premiums since that time have remained very stable. We have seen an increase in overall building insurance premiums over the last 3-4 years but not in the wake of extreme weather events. If prevention measures are constantly upgraded and there is no "tipping point" of sudden extreme climate change, we expect an average annual increase in extreme weather insurance premiums along the "ideal" rate of inflation (~ 2 %). | | General storm insurance premiums have increased by about 3% annually, with a further increase of about 1% annually | They have increased very significantly. With Flood Re in place premiums and excesses for those most at high risk will be constrained, but will be released again once the scheme comes to an end in 2039. Overall they will increase. | Accurate values many not known. Since 1990, the total was insured, the high fees associated with low penetration. increased until 2012 the charges, since the introduction of solid MKR premium reduction can be observed. It is expected to grow, stagnate or in addition to increasing absolute contribution. |

*Table A4.6 Score of self-assessment on the success of an insurance market*

| | Spain | Sweden | Germany | EU wide | The United Kingdom |
|---|---|---|---|---|---|
| **The insurance penetration rate (i.e. the percentage of potential policyholders with an insurance policy).** | Insurance is provided as a compulsory extension of most insurance. This creates a high penetration rate | All household insurances and insurances for SMEs have cover. To keep the penetration the municipalities and state have to adapt risks from climate change | Very good sales figures with new policies, difficult sale to business in force. There is a lack of risk awareness and loss compensation by the government. Government has to stop ad hoc loss compensation and communicate this to the public. Risk awareness should be further strengthened. | Most public schemes high-levels of penetration mainly due to requirements. | Flood Re was introduced in April 2016, 53,000 properties were reported as being in the scheme by September 2016, with a possibility of about 350,000 |
| **The ability of insurance to act as a signal of risk or to promote risk management and preparedness.** | The surcharges are not linked to the risk and don't act as signals of particular risk levels. CCS devotes part of its resources raise awareness and promote DRR. | We try to promote risks, but it is not always well received from the municipalities and state since adaptation costs | Risk based pricing is already in place in Germany. Very good location based information about the risk available. | Most (if not all) public schemes (weather-related) have limited risk variation in premiums charged. | It has the potential, but is not delivering this yet. |
| **The ability of the insurance sector to be able to absorb large losses.** | Well established PPP. Insurance Compensation Consortium covers extraordinary losses, and is financed through a flat rate, with the potential of government support. | | The Solvency II regime at EU level does all the necessary regulation. The market is able to cope with large scale events. | A critical function of public schemes is to support the insurance sector's ability to absorb large losses although there have been very few (if any) examples of governments needing to provide support to the insurance sector to cover losses (most government funding after disasters has been to cover uninsured losses). | This is one of the things that the scheme is designed to do |

| | Spain | Sweden | Germany | EU wide | The United Kingdom |
|---|---|---|---|---|---|
| **The ability to provide quick and certain compensation payments after a disaster event** | There is legal certainty about the compensation payments. CCS controls the whole loss adjustment and claim process is quick and straightforward. | It is a matter of definition of quick. The damage have to be assessed, which can take some while. Meanwhile, compensation is payed, but not to the full amount. | Expertise and workforce for loss adjustment are in place or available on short call. | It is unclear whether there is any advantage in this regard in having a public insurance scheme. | It is up to each member insurance company to do this. However, there may an opportunity to compare practices between insurance companies once there is sufficient data |
| **The affordability and availability of insurance policies / premiums.** | The binding nature of the extension of the coverage and the wide base of policyholders allow for very affordable premiums. In effect premiums are highly subsidized. | The cost is low due to large penetration | Approx. 95 % of all private buildings can be insured against for under 200,- EUR p.a. with full replacement value compensation under all future building codes. | This is where public insurance schemes have been most successful in ensuring that insurance is available and affordable. Public insurance schemes that achieve broad coverage would normally be able to provide insurance coverage for cheaper based on their ability to pool a large number of risks. | Calls to our advice line reflect that many people are now able to access more affordable insurance than in the past. |
| **Self-assessed score (1-3)** | 2,8 | 2,4 | 2,8 | 1,1 | 2,3 |

***Table A4.7 Aggregated national monetary losses ('000 USD) from the extreme weather events studied.***

| | Bulgaria | Demark | Germany | Spain | France | Italy | Hungary | Austria | Poland | Romania | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | | 190000 | 4440000 | 4500000 | 1910000 | 20000 | | 250000 | 50000 | | 10000 | 4790000 |
| 1991 | | | 5000 | | 772000 | | | 110000 | | 50000 | | 900000 |
| 1992 | | 751700 | 30100 | | 400000 | 697300 | 384000 | | | | | |
| 1993 | | | 1010000 | | 1150000 | 625000 | | 1000 | | | | 187000 |
| 1994 | | | 1438700 | | 100000 | 9300000 | | 2000 | 1000 | 3000 | | 236000 |
| 1995 | | | 529600 | 824300 | 700000 | | | 200 | | 3400 | | 650000 |
| 1996 | | | 500 | 576600 | 6010 | 32000 | | 5000 | | | | 300000 |
| 1997 | | | 360000 | 5000 | 10000 | 800000 | 10000 | 175000 | 3500000 | 110000 | | 248400 |
| 1998 | | | 150000 | 1000 | 150000 | | | | | 150000 | | 1865400 |
| 1999 | | 2604939 | 2180000 | 3300000 | 12500000 | | 293400 | 32000 | 10000 | 60000 | 160000 | 133680 |
| 2000 | 50 | | | 75000 | | 8050000 | 55000 | 20000 | | 600500 | | 7418150 |
| 2001 | | | 300000 | 72000 | 132350 | 275000 | 5000 | | 700000 | 135000 | | |
| 2002 | 1000 | | 13650000 | 87000 | 1191000 | 646000 | 30000 | 2405000 | 150 | 290 | | 400050 |
| 2003 | | | 1950000 | 880000 | 5900050 | 5205000 | 100000 | 280000 | | | | |
| 2004 | | | 130000 | 14285 | | | | | | | | 96000 |

| | Bulgaria | Demark | Germany | Spain | France | Italy | Hungary | Austria | Poland | Romania | Sweden | United Kingdom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | 457000 | 1300000 | 790000 | | | | 48000 | 700000 | | 1313000 | 2800000 | 700000 |
| 2006 | | | | | | | 10000 | | | | | |
| 2007 | | 100000 | 5500000 | 400000 | 250000 | | | 400000 | 100000 | | | 9648000 |
| 2008 | | | 2700000 | | 80000 | 278000 | | 500000 | 50000 | | | 50000 |
| 2009 | | | 70000 | 1900000 | 3200000 | 20000 | | 700000 | 100000 | | | 484000 |
| 2010 | | | 1000000 | 340000 | 5730000 | 872000 | 440000 | | 3080000 | 1111428 | | 500 |
| 2011 | | | | | | 545000 | | 1000000 | | | | |
| 2012 | 4400 | | | 395000 | | 1337601 | | | 5900 | | | 2946000 |
| 2013 | | | 17700000 | | 655000 | 780000 | | 1000000 | | 11000 | | 1500000 |
| 2014 | 932000 | | 400000 | | 485000 | 1087000 | | | | | | 724000 |
| 2015 | 5800 | | | | 924000 | 1143000 | | | | | | 2400000 |

*Notes: Data from EM-DAT presented in market prices at the time of impact*

## APPENDIX 5
## REPORT ON FINAL EVENT (30.06.2017)

### *Introduction*

Towards the end of this study, Ramboll and IVM organised a stakeholder consultation in the form of a conference. The main purpose behind this event was for Ramboll and IVM to present the findings of this report to relevant stakeholder groups, particularly stakeholders of the insurance industry, public authorities, and agriclture. This was envisaged to achieve two things: first, it would generate feedback on the findings of this report from relevant stakeholders, which could then be integrated in its finalisation; and second, it would disseminate the findings of this study.

Ramboll and IVM sought to achieve a balance in the composition of stakeholders attending the event in accordance with their relevance to the findings of this report. Among the 76 participants who had signed up to the event, 25 represented the insurance industry, 25 represented public sector organisations[21], 9 represented research organisations[22], 6 represented agricultural interest groups, 2 represented non-governmental organisations, and the remaining 9 represented consultancies[23]. Of the 76 invitees who had confirmed their attendance, XX were present at the event.

The event was held between 10.00 and 17.00 on the 30 of June 2017 at the premises of the European Commission, at Rue Philippe Le Bon 3 in Brussels.

Below is a summary of the proceedings of the event[24].

### *Welcome / Opening*

Dr. Kondrup (EU DG Clima) emphasized that the focus of climate change adaptation should be on providing strong support to cities and making infrastructure more resilient and linked this to the US where there exists a strong support from cities regarding climate change adaptation. Insurance needs to be in line with this and meet the needs of stakeholders.

Ms. Boulehouat (EU DG Echo) encouraged to enforce Disaster Risk Management using, among other tools, insurance. She argues that the focus of the EU needs to be on pushing for strong collaboration between the private and public sectors.

### *Session 1 – Promoting risk awareness and reduction*

The issue of affordability should be addressed. Especially for low-income households, it is important to alleviate the financial risk by encouraging taking out extreme weather insurance coverage by providing insurance vouchers or tax credits. Regarding indirect measures of DRR, the idea of requirements to obtain insurance (e.g. building codes) should be strengthened.

Tom Herbstein (ClimateWise) focused on ClimateWise's vision of where the insurance industry can go in the future. He addressed the challenge of the protection gap and explained that the current market is very challenging. He argued in favour of increasing regulatory attention, both in the UK and abroad. Communication through risk pricing is only one part; there should be done more, for example a focus on: cities (i.e., multisector partnerships with industry and other stakeholders), investment (i.e., recognizing the huge potential in asset management and the need for benchmarking tools), regulation (i.e., supporting regulators' council). It is important for the industry to take a leadership role.

Michael Szonyi (Zurich flood insurance alliance) argues that the goal should be to promote investments so others will join too. They aim to capacitate NGOs and public sectors, and support multisector alliances. In providing examples of solutions, he mentions: the development of the first validated flood resilience measurement framework which is in line with Sendai Framework, the Post Event Review Capability (PERC) and cross-cutting learning and sharing enabled by their floodresilience.net.

[21] Among these, 12 from European institutions.

[22] Among these, four from IVM.

[23] Among these, five from Ramboll.

[24] The agenda for the event can be found in Appendix 6.

Inés Isabel La Moneda (ENESA) discusses the Spanish agriculture insurance system. She explains that many perils are covered, participation is voluntary, and insurance policies subsidized. They have an average penetration rate of 40% but it differs from crop to crop. She argues that the success of the system is due to the collaboration between the actors from public and private sectors. Regarding risk awareness and risk reduction she mentions the minimum requirements (admin, economical and technical), premium discounts for implementing DRRs, and the use of the bonus-malus system. She concludes that their system has advantages for the insurance market as well as the farmers.

The following is a summary of the follow up questions and discussions with the audience:

- It would be interesting to analyse the surcharge compared to the general taxation?
  - The study did not look at the specific differences between a surcharge and general taxation.
- One of the recommendations is to support low-income households through subsidies, though a recent conference showed affordability is not an issue. When affordability is not the problem, how can the issue of low penetration rates be solved?
  - It depends how you define affordability.
  - Although politically challenging, don't pay out premiums to those who did not take out insurance coverage.
- Although a great idea in theory, there is debate about the practicality of implementation of a resilience-label.
- Who will be regulating the funds if tax increases or a surcharge is enforced?
  - Each country should have their own body that will regulate the funds. This is not recommended to do on a EU-wide level.

***Session 2 – Closing the protection gap***

The report's findings show that it is recommended to promote the bundling of perils to create multi-peril crop insurance. Furthermore, banks should be urged to require full and comprehensive insurance and a focal point or authority should help to bring together the different stakeholders.

Thomas Hlatky (GRAWE) chairs this session and discusses the issue of closing the protection gap. Risk transfer should be at the core of the insurance industry. He also discusses whether it should be called a protection gap or a protection vacuum. This leads to the addressing the following important question: how do you build a bridge in a vacuum?

Paola Grossi (Coldiretti) responds that their main goal is to increase farmers' awareness. Perils cross country boundaries and therefore policies could have important role in enforcement. For example, in Italy, farmers need to insure a minimum of 3 perils, but some insure up to 9. Therefore, the share has increased significantly. She does acknowledge that mandatory protection is very difficult.

Wouter Botzen (IVM-VU) poses the question of why there is a protection gap. Recent academic studies show that people tend to purchase insurance after a disaster hit. So awareness, or lack thereof, is one part of the causes but the situation is more complex. Some governments provide funds after a disaster also to those without insurance coverage, hence there is less incentive for people to get coverage. Some solutions to this could be to develop awareness campaigns which can help, although the time span is limited. Furthermore, government compensation could be provided through loans or only to people who are then required to purchase insurance going forward. Summarizing, there is potential for advancing the markets but it will then limit consumers' freedom which is a sensitive issue.

Laura Schaefer (MCII) focuses in her work on developing countries and will therefore take the debate to a global perspective. She explains that in developing countries only 2% of the losses is covered by insurance. When comparing this to EU and the US, it appears that in developing countries people can't rely on insurance and coping means to sell assets while they actually need the insurance safety net. Therefore, they need a regulatory environment that incentivizes people to take out insurance and partnerships are necessary. The debate should not only be about quantity but also quality: insurance needs to be affordable, accessible and sustainable. Insurance solutions need to be imbedded in DRR management.

Eddy Vanbeneden (Guy Carpernter) argues that the transferring of risk to the private market should be promoted. There is still room to improve the public-private partnership and there is increased recent willingness to cultivate the initiatives, especially after events. He also supports the bundling of perils in one offer and mentions that it is good to have the legal environment in a country for the social-environment.

The following is a summary of the follow up questions and discussions with the audience:

- It is mentioned that the differentiation by actuarial scientists between different perils that can occur simultaneously, such as storms, hails etc., is not very workable. An example of this are last year's problems in the Netherlands. Because of climate change, you need changes in the wording of clauses so insurance buyers become more confident.
- Compliment on the excellent timing of the conference. Linking to the previous point, information sharing should be improved to build better trusts between the insurers and buyers. What would you think of creating an observatory at EU level that monitors climate risk and provide info and expertise on how to access insurance schemes?
    - Mr Vanbeneden agrees and thinks this is in line with what Thomas mentioned. The existing models are sophisticated but only look at one peril. They need a scenario approach. He also agrees that language needs to be improved.
    - Mr Hlatky: talked to Max and we are taking the models too seriously. We are missing the point.
- Fire insurance in Italy is inversely related to outcome risk so it is not a solution; so how could we solve the problem?
    - Mr Hudson: same problem as mentioned beforehand. Things might work for the EU as a whole, but need to be studied in detail to identify country-level solutions.
    - Mr Botzen: the relevant issue is with the bundling of perils. For a consumer, the differentiation between perils such as hail and storm is difficult to make. This creates a low demand of disaster insurance which could be address by bundling. This is very beneficial for consumers but maybe less for the insurers. However, for local situations it could be a solution.
- The idea of a protection gap in the EU is challenged: it might exist in developing countries but not here. An info data bank would need to be fed by many companies but the likelihood of this actually happening is deemed very low. Furthermore, recommendations should be addressed not to the EC but to countries or sub-national level.
- Thomas has a question to the EC: if we don't follow these recommendations, we will be drive back to a pre-insurance age and that the gap is widening. Then it could be that society would become more individual reliant.
    - Max Linsen responds that none of the recommendations are invented by us but based on input obtained from a group of stakeholders. The main idea of the recommendations is to create an environment where insurance can have a role to improve DRR. Today's questions are also very much focused on insurance itself rather than its potential as a tool for DRR.

### *Session 3 – The role of public and private entities in the risk cycle*

The report recommends to use a surcharge on private property insurance premiums to directly finance and construct risk reduction infrastructure. For agriculture, it is recommended to develop a risk management association with a focus on protecting farmers against income variations due crop yields. This can be achieved by supporting multi-risk yield insurance or the employment of risk reducing measures. A working group in the European Commission could be used to enable cross-DG collaboration and coordination with national bodies.

Peter Schulze (EC DG ECFIN) moderated this session, emphasising the complexity of the EC in certain PPP situations. Furthermore, he recognized the challenges for the private sector in terms of cooperating in a PPP setting.

Leigh Wolfram (OECD) started her talk off with showing the importance of risk transfer instruments in the recovery after an economic disruption by a natural hazard. However, although the risk has been increasing over time, insurance coverage has not. For PPPs, she firstly recommends to ensure the availability of necessary data, technology and expertise for quantifying exposure to catastrophic risk by collaborating across sectors. She also highlights the need to support insurability and affordability (e.g. raising risk awareness and risk reducing measures).

Swenja Surminski (London School of Economics) followed with her talk on supporting comprehensive climate risk management through insurance and the roles for the public and the private sector. Her vision is that communities and businesses are well adapted so that losses are kept to a minimum and do not lead to unnecessary public budget reallocations, but are shared through efficient private markets. In addition, the public sector can set a resilience-supportive framework and look after those who are most vulnerable. In order to achieve this vision, the insurance industry can support resilience efforts by offering risk transfer, risk device and information and investments. The latter is mostly focused on prevention and adaptation efforts to avoid new risks and high losses, though restricted as there is currently a lack of business case for resilience.

The following is a summary of the follow up questions and discussions with the audience:

- Creating a new working group is less desired. Rather, there is the suggestion of improving the existing bodies and make better use of existing knowledge and information.
- There is still huge potential to account for resilience. Currently we spend much more money on repair and recovery rather than preparedness. One of the reasons for this that the private sector struggles to internalize risk. We need to create and foster the development of a positive narrative about resilience.
- Risk landscape is changing so continuing innovation in required to deal with the challenges.

### *Session 4 – The role of cities and regions*

From the report's results, it is recommended to fund projects under the LIFE Programme for the Environmental and Climate Change 2014-2020 to increase the capacity of cities to use insurance as a risk management tool and insure infrastructure. In addition, a dialogue should be created between the insurance industry, municipalities and national bodies on how community rating systems and city pooling can be developed.

Moderator: Sandro Nieto Silleras (EC DG CLIMA)

Alberto Terenzi (ICLEI) started this session of by asking the question: insuring whom, insurance what? He emphasises the current challenges of cities, such as growing urban population, infrastructural demands, and climate change mitigation and adaptation. Cities are often seen as a single actor, while they entail a broader spectrum of actors and stakeholders. Risk reduction has to be imbedded into a larger sustainability strategy.

Mia Ebeltoft (Finance Norway) shows that the Norwegian insurance system is a solidarity scheme, with a flat premium and a 100% insurance penetration rate. However, urban flooding (e.g. sewage backup) is not a part of NatCat insurance, but is costlier than all the NatCat losses. Using insurance loss data, she showed that a loss database could contribute in finding previously unknown risks, improve understanding of how climate change affects society, and helps with better collaboration within the municipalities. Her case study shows the importance of sharing insurance loss data in a save and controlled manner.

Jan Rasmussen (City of Copenhagen) closed the session with a case study on the City of Copenhagen. A cloudburst over Copenhagen, with 150 mm in 2 hours, and about 1 billion euro in damages, this was a game changer for the city leading to the development of the Cloudburst Management Plan. The Cloudburst Management Plan aimed to secure the city up to a 100 year cloud burst in a 20 year time span. By partnering with the insurance industry on a city level, insurance premiums could be lowered, to compensate for increasing water taxes, maintaining a balance is costs for the citizens of Copenhagen. Other benefits included the use of insurance data and direct communication with citizens.

The following is a summary of the follow up questions and discussions with the audience:

- There is a need to create a dialogue between communities, industry and national bodies.
- It is suggested to incorporate recommendations regarding the region level as they are quite powerful.

### *Closing remarks*

Christian Nyerup Nielsen (Ramboll)

- We are grateful to have received a lot of input.
- Stakeholder engagement has been an important dimension of the project and we hope that discussions will continue
- Business case for use of insurance against climate changes losses exist but it requires close cooperation between public and private sector at meso-level

Max Linsen (European Commission)

- Realistic expectations
- Connecting dots
- Create a framework/environment by governments and business cases by private sector.
- Resilience as a system.
- Focus:
    - Formulate common information needs.
- Future:
    - Scrutinize the recommendations.
    - What is the right level of facilitation?

## APPENDIX 6
## DISTRIBUTED AGENDA FOR THE FINAL EVENT

## CONFERENCE AGENDA: INSURANCE AND CLIMATE RELATED DISASTERS

### Brussels, 30th of June

| | |
|---|---|
| **9:30 - 10:00** | **REGISTRATION** |
| **10:00 - 10:45** | **WELCOME, PURPOSE AND BACKGROUND OF THE MEETING**<br>***Claus Kondrup***– European Commission, DG CLIMA<br>***Naçira Boulehouat*** - European Commission, DG ECHO<br>***Xavier Le Den*** – Ramboll |
| **10:45 - 11:45** | **SESSION 1: PROMOTING RISK AWARENESS AND REDUCTION**<br>Moderator: ***Laura Schmidt***- European Commission, DG ECHO<br>Introduction of policy recommendations: ***Paul Hudson*** – IVM<br>Key notes:<br>***Tom Herbstein*** – ClimateWise<br>***Michael Szönyi*** – Zürich Insurance<br>***Inés Isabel La Moneda***– ENESA (National Agency on Agricultural Insurance, Spain)<br>Questions |
| **11:45 - 12:45** | **SESSION 2: CLOSING THE PROTECTION GAP (PANEL DISCUSSION)**<br>Moderator: ***Thomas Hlatky*** – GRAWE<br>Introduction of policy recommendations: ***Paul Hudson*** – IVM<br>Panel:<br>***Paola Grossi -*** Coldiretti<br>***Eddy Vanbeneden -*** Guy Carpenter<br>***Laura Schaefer*** – MCII<br>***Wouter Botzen*** – IVM<br>Questions |
| **12:45 - 13:30** | **LUNCH** |
| **13:30 - 14:30** | **SESSION 3: THE ROLE OF PUBLIC AND PRIVATE ENTITIES IN THE RISK CYCLE**<br>Moderator: ***Peter Schulze*** - European Commission, DG ECFIN Intro-<br>duction of policy recommendations: ***Matilda Persson*** – Ramboll Key<br>notes:<br>***Leigh Wolfrom*** – OECD<br>***Swenja Surminski***– London School of Economics<br>Questions |
| **14:30 - 14:45** | **COFFEE BREAK** |
| **14:45 - 15:45** | **SESSION 4: THE ROLE OF CITIES AND REGIONS**<br>Moderator: ***Sandro Nieto Silleras***- European Commission, DG CLIMA<br>Introduction of policy recommendations: ***Matilda Persson*** – Ramboll<br>Key notes:<br>***Mia Ebeltoft*** – Finance Norway<br>***Jan Rasmussen*** – City of Copenhagen<br>***Alberto Terenzi*** – ICLEI<br>Questions |
| **15:45 - 16:00** | **WRAP UP REMARKS**<br>***Christian Nyerup Nielsen*** - Ramboll<br>***Max Linsen*** - European Commission, DG CLIMA |
| **16:00 - 17:00** | **NETWORKING DRINK** |

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