



“NAture Insurance value: Assessment and Demonstration”

NAIAD

SC5-09-2016 Operationalising insurance value of ecosystems
Grant Agreement n° 730497

Deliverable 7.5

European survey on insurance systems and Natural Assurance Schemes (NAS)

Due date of deliverable: 28/02/2020
Actual date of submission: 13/02/2020

Start date of project: 01-12-2016

Duration: 42 months

Name of partner responsible for deliverable: ICA

Authors: Marchal R., Piton G., Tacnet J-M., Zorrilla-Miras P., Lopez-Gunn E., Moncoulon D., Altamirano M., Matthews J., Joyce J., Nanu F., Groza I., Peña K., Dartée K., Pengal P., Cokan B., and van der Keur P., Burke S., Graveline N., (2017): “Deliverable 7.5 - European survey on insurance systems and Natural Assurance Schemes (NAS)”. EU Horizon 2020 NAIAD Project, Grant Agreement N°730497

Dissemination Level		
PU	Public	
CO	Confidential, only for members of the consortium (including the Commission Services)	X

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730497.

The opinions expressed in this document reflect only the author's view and in no way reflect the European Commission's opinions. The European Commission is not responsible for any use that may be made of the information it contains.





1. Edition information

Tableau 1 : Versions

VERSION	EDITION DATE	MODIFICATION	WRITTEN BY	CONTROLLED BY
0.1	01-MARCH-18	FIRST EDITION	MARCHAL R.	PITON G., & TACNET J-M.,
0.2	02-MAY-18	SEVERAL MODIFICATIONS		ZORRILLA-MIRAS P., & LOPEZ- GUNN E.,
0.3	23-MAY-18	SEVERAL MODIFICATIONS		MONCOULON D.
0.4	28-MAY-18	MERGING COMMENTS		MARCHAL R.
0.5	26-JULY-18	MERGING COMMENTS		PENGAL P. & MARCHAL R.
FINAL	19 JAN 20			LOPEZ GUNN, MAYOR B.



Nature Insurance value: Assessment and Demonstration

European survey on insurance systems and Natural Assurance Schemes (NAS)

*Perspective from literature review and interviews with people active in
(re)insurance companies and related sectors*



Acknowledgements

Special gratitude goes to the many international and European (re)insurers that participated in the NAIAD survey. We would like to kindly thank the German Insurance Association, Flood Re, Unipol/ANIA, Neerlandse, Finance Norge, Forsikring & Pension, Caisse Centrale de Réassurance,

We would like to thank also all the NAIAD partners that have contributed to the design of the survey and that have reviewed the final report. These include, IRSTEA (Jean-Marc Tacnet, Guillaume Piton), Deltares (Monica Altamirano), ICATALIST (Elena Lopez-Gunn, Pedro Zorrilla Miras), SIWI (John Joyce), CCR (David Moncoulon), and BRGM (Nina Graveline). We are also grateful to the Business Development Group (Florentina Nanu, Ioana Groza), Field Factors (Karina Peña, Kieran Dartée), Revivo (Polona Pengal, Blaz Cokan), GEUS (Peter van der Keur), and Ambiotek (Sophia Burke) for their participation in the interviews survey definition and execution.

List of abbreviations

A	N
Administration for Civil Protection and Disaster Relief (ACPDR), 21	National Adaptation Plans (NAPs), 40 Natural Infrastructure Scheme (NIS), 53 nature assurance scheme (NAS), 8 Nature Insurance Value: Assessment and Demonstration (NAIAD), 8 nature-based solutions (NBS), 8
C	P
climate change adaptation (CCA), 12 Consorcio de Compensacion de Seguros (CCS), 35	Prudential Regulation Authority (PRA), 40
D	T
Danish Storm Council (DSC), 27 disaster risk management (DRM), 12	Total Economic Value (TEV), 20
E	W
Eco-disaster risk reduction (eco-DRR), 53 European Union (EU), 11	Wet Tegemoetkoming Schade bij rampen (WTS, Calamities Compensation Act, CCA), 27
I	
insurance value of ecosystems (IVE), 8	



INDEX

1.	Edition information	2
2.	Executive summary	9
3.	Introduction.....	12
3.1	Objectives of the survey.....	13
3.2	Global methodology	14
4.	Methodological approach	14
4.1	Geographical scope	14
4.2	Literature review	14
4.3	Interviews.....	15
4.3.1	Recruitment of participants	15
4.3.2	Semi-structured interviews.....	16
5.	Literature review	19
5.1	Disaster risk reduction, nature-based solutions and insurance value of ecosystems 19	
5.2	European natural hazards insurance business models	21
5.2.1	General perspective	21
5.2.2	Country fact sheets	23
5.3	Insurers' views on disaster risk reduction.....	46
5.4	Challenges to insurance caused by disaster risk reduction.....	50
5.5	Insurance addressing disaster risk reduction.....	54
5.6	Recent developments related to disaster risk reduction (DDR), climate change adaptation (CCA) and NBS.....	62
6.	Interview results.....	63
6.1	The insurance industry vision of climate change	65
6.2	The insurance industry' understanding of nature-based solutions and the insurance value of ecosystems	67
6.3	(Eco)-Disaster risk reduction is challenging the insurance industry	70
6.4	Roles of the insurance industry in supporting (eco)-disaster risk reduction	74



6.4.1	Insurers as co-developers/innovators.....	74
6.4.2	Insurers as providers	75
6.4.3	Insurers as investors.....	78
6.4.4	Insurers as partners.....	80
6.5	Relationships between the insurance industry and the European Union for DRR 83	
6.6	Main findings from the interviews	85
7.	Recommandations and conclusions.....	87
8.	References.....	90
9.	Appendixes.....	97
9.1	Appendix 1 : Full questionnaire.....	97
9.2	Appendix 2: The Grounded Theory	103
9.3	Appendix 3: Database Interview structure	104
9.4	Appendix 4: Classification of European insurance system.....	104
9.5	Appendix 5: The NFIP Program	111
9.6	Appendix 6: the Natural Infrastructure Scheme (NIS)	112

List of tables and figures

Figure 1: Country fact sheet for Germany	28
Figure 2: Country fact sheet for Italy	29
Figure 3: Country fact sheet for Slovenia	30
Figure 4: Country fact sheet for Norway	31
Figure 5: Country fact sheet for Denmark	37
Figure 6: Country fact sheet for Sweden	38
Figure 7: Country fact sheet for United-Kingdom	39
Figure 8: Country fact sheet for Netherlands	40
Figure 9: Country fact sheet for France	43
Figure 10: Country fact sheet for Spain	44
Figure 11: Country fact sheet for Romania.....	45
Figure 12: Selection of the core references related to climate change, disaster risk reduction, ecosystem services/NBS) and the insurance industry (References: European Commission 2015, Francis et al. 2016, Narayan et al. 2016, World Wide Fund and US AID 2016, Tipper and Francis 2017, WBCSD 2017, Weingärtner et al. 2017, Colgan et al. 2017).....	47



Figure 13 : Comparison between the European and the Rest of the World, companies and institutions' involvement in the PSI (Reference: www.unepfi.org/psi , 2017)	49
Figure 14: The European insurance sector and institutions involvement in the UNEP Principles for Sustainable Insurance (Reference: www.unepfi.org/psi , 2017).	49
Figure 15: A poster from The Nature Conservancy on the RRIF, 2017	60
Figure 16: Interviews per NAIAD country	63
Figure 17: The panel of interviewees	64
Figure 18: Interviewees in relation to the (re)insurance sector	64
Figure 19: Climate change a challenge for insurers' models (34 responses)	66
Figure 20: Current state of knowledge of Nature-based solutions for risk reduction (39 responses)	67
Figure 21: Current state of knowledge of the insurance value of ecosystems (27 responses)	68
Figure 22: Current integration state of ecosystems effects into catastrophe models (41 responses)	69
Figure 23: Current integration state of ecosystems effects into catastrophe models (27 responses)	70
Figure 24: Main natural hazard following insurance industry perception (160 responses)	71
Figure 25: Graphic representation of Grounded Theory' steps (References: Marchal R., IRSTEA, 2017)	103
Figure 26: Practical example to apply Grounded Theory's steps, (References: Marchal R., IRSTEA, 2017)	103
Figure 27 : One unique database to facilitate data analysis (References: Marchal R., IRSTEA, 2017)	104
Figure 28 : The three main market classifications (Reference: (Le Den and Kuik 2017 p. 50)	105
Figure 29: Indication of insurance penetration, (Reference: (Le Den and Kuik 2017 p. 51)	105
Figure 30: France (mandatory insurance) and Denmark (voluntary insurance), two examples of modulation of the deductibles according to the recurrence of disasters (References: CCR & Danish Storm Council 2017).	106
Figure 31: Premium setting rules (Reference: (Le Den and Kuik 2017 p. 52)	107
Figure 32 : Incentive types, often a deductible-based risk reduction (Reference: (Le Den and Kuik 2017 p. 53)	107
Figure 33 : Reinsurance types (References: (Le Den and Kuik 2017 p. 53)	108
Figure 34 : Governmental disaster funds (ad-hoc or dedicated funds) (Reference: (Le Den and Kuik 2017 p. 53)	108



Figure 35: Credit point required to reach given protection classes and the related possible discount (National Flood Insurance Program 2015 p. 3)	111
Figure 36 : How the Natural Infrastructure Scheme (NIS) could works? (source: (Francis et al. 2016 p. 3 and 27)).....	112
Figure 37: Comparison between current costs in the BAU and cost saving in the NIS (Reference: (Tipper and Francis 2017 p. 3)	113
Figure 38 : Three conditions necessary to implement the NIS (Reference: (Tipper and Francis 2017 p. 7)	113



In brief

This NAIAD report is based on a literature review and interviews with 61 people active in (re)insurance companies and related sectors in 11 European countries, performed in 2017. This aim of the study was to offer new insights on the role the insurance industry could play to help address the goals of disaster risk reduction and adaptation to climate change, looking particularly at new opportunities around nature-based solutions, both by comparing different insurance systems and by giving a global overview.

NAIAD: WP7

The H2020 European project Nature Insurance Value: Assessment and Demonstration (NAIAD) has been designed to deepen our knowledge on the Insurance Value of Ecosystems (IVE), to understand to what extent Nature-Based Solutions (NBS) can help in water-related risk prevention and mitigation.

Part of Work Package 7 (WP7) was to conduct a survey on how European insurance systems differ from one to another, to consider ecosystems as a potential reliable means to help reduce risk. The NAIAD consortium consequently launched a questionnaire-survey to go deeper building on a literature review to understand potential future strategies and prospects by having a global view of the European insurance market functioning particularly in relation to the operationalization of the insurance value of ecosystems.

2. Executive summary

The survey provides an overview of the current set of European natural hazard insurance systems and current knowledge and opinions from different stakeholders on NBS and IVE. It provides general recommendations for the different European insurance systems and discusses the potential integration of nature-based solutions and natural assurance schemes (NAS) into these insurance systems.

This Deliverable has been synthesized within the paper so-called: Marchal, R.; Piton, G.; Lopez-Gunn, E.; Zorrilla-Miras, P.; Van der Keur, P.; Dartée, K.; Pengal, P.; Matthews, J.; Tacnet, J.-M.; Graveline, N.; et al. The (Re)Insurance Industry's Roles in the Integration of Nature-based Solutions for Prevention in Disaster Risk Reduction—Insights from a European Survey. *Sustainability* **2019**, *11*, 6212. Available online: <https://www.mdpi.com/2071-1050/11/22/6212>

This deliverable highlights:

- the implemented methods:
 - to perform the literature review,
 - to select the targets,
 - to produce the questionnaire,



- the methodology to perform the interviews,
- the results from the literature and
- results from the interviews and finally
- analysis and discussion of the results.

European & worldwide climate change adaptation, disaster risk reduction and nature-based solutions issues

The year 2017 showed record insured losses from natural catastrophes, water-related disasters are among the highest risks to our societies (Munich Re 2017, Swiss Re 2017). Only recently the climate change debate has moved to be linked to other concepts such as disaster risk reduction (DRR) and nature-based solutions (NBS). Climate and disaster responses are needed in prevention measures and adaptation strategies implementation. These concepts are starting to gather together scientists and industrials for risk management global/local responses. There is as well an increasing interest for common definitions, policy orientations and for transdisciplinary research involving governments, public and private sectors.

Ecosystem-DRR as multiple benefits

In-depth studies on how works the different European natural hazards insurance systems help stakeholders and policymakers to better understand the impacts of climate change and natural disasters on nation's finance and economy. 2015 was the year of climate change researches in the insurance industry (Réassurance 2015, Surminski et al. 2016). 2018 is the year of researches based on new ways to link, CCA/DRR/NBS across different sectors (Dow et al. 2013, Beck et al. 2016, Narayan et al. 2017, Colgan et al. 2017).

Paradigm shift from ex-post to ex-ante measures

Insured and non-insured losses due to natural disasters are largely increasing (Swiss Re, Munich Re, CCR) and the difficulty is to assess direct and indirect damages. There is an increasing interest in preventive measures implementation, a paradigm shift from ex-post to ex-ante measures. This current shift is based on moving toward nature-based preventive measures more and more integrated into risk management frameworks. There is on-going willingness to move towards effective and sufficient ex-ante measures providing incentives to people, businesses and governments. Some of European natural hazard insurance systems are facing protection gap and function changes, multiple last year and current reforms of insurance schemes as a result.

Role of the insurance industry

Based on interviews with (and written responses from) 61 (re)insurers and linked stakeholders, new insights are offered into the role of the insurance industry as providers,



investors, partners and co-developers (innovators) in addressing disaster risk reduction. The insurance industry is one part of the solution, not the panacea. Climate change is on the agenda of the insurance industry (Warner and C. Herweijer. 2009, Tanner et al. 2015, Surminski et al. 2016). Prevention is starting to be the new one (Dow et al. 2013, Francis et al. 2016, Tipper and Francis 2017). The industry is contributing significantly to studying climate change impacts, preventive measures, to offer new insurance products, to create innovative risk financing products, services and mechanisms.

Challenges and recommendations

The insurance industry is starting to be more involved in prevention. Some key challenges were identified that need to be addressed by the insurance industry itself and related stakeholders through consistent policies and partnerships.

Recommendation 1: The European Commission has to consider the specifics of insurance schemes to be able to reinforce and create harmonized linkages between climate change adaptation/disaster risk reduction (CCA/DRR) policies and insurance businesses. New policies mainstreaming ecosystem based-disaster risk reduction measures (Eco-DRR) and insurers' contribution, could be based on public-private partnerships (PPPs). Thus, it is an opportunity to promote risk awareness, risk reduction and to bridge the knowledge gap in the insurance industry on preventive measures.

Recommendation 2: The interviews revealed the need for Nature-based Floods-Directive, based on the same principle of the Floods Directive (risk maps integrating protective measures, greener risk financing). The interviews revealed the need for clear European and national roadmaps for sustainable insurance. However, there are divergent opinions on the idea of an EU imposition. This is linked to the EU proposal to foster insurance industry in DRR.

Recommendation 3: Projects like NAIAD scale-up experimenting, testing and demonstrating the applicability of NBS, challenge the EU on the policy interaction between NBS implementation and current protected areas (Natura 2000, ZNIEFF etc.) The EU could base future policies on NAIAD standards for NBS implementation. The key challenges are to determine the insurance value of ecosystems and to assess the multiple benefits of DRR whether disaster strikes or not. We should face the undergoing rapid changes by increased integration of approaches.



3. Introduction

One of NAIAD's key objectives is to provide insurers, investors and other stakeholders with concrete information and possible management steps that these decision-makers could take to respond to climate change challenges and disaster risk management. Links between disaster insurance and nature-based-solutions have now merged into the concepts of "*insurance value of ecosystems*" and "*nature insurance value*". NAIAD studies the role of insurance as a potential tool to secure their risk mitigation services based on environmental conservation and restoration.

The core of the insurance business is based on risk transfer¹, where sharing the cost of risks (mutualisation) enables equitable and affordable insurance contracts against on the one hand, low probability-high impact, and on the other medium to high probability-low impact risks. As providers, insurance companies underwrite the protection for people, businesses and governments in return for a premium. Premiums reflect the probability of occurrence for the insured event². When the covered event occurs, insurance companies play a key role in post-disaster recovery of damages by policyholders through their compensation (indemnification). To calculate economic losses, the insurance sector uses risk modelling to identify the best risk-pricing. These models however can generate deep uncertainties, notably on aspects related to event frequency and on vulnerability assessment (Dr. Marescot 2013, Pimbert 2014). These limits are overcome as best as possible by companies to avoid their insolvency and bankruptcy. The resilience of this mechanism therefore relies on risk pooling, reinsurance and retrocession³.

This report aims to outline the current European Insurance Systems' framework as part of a survey on European Insurance Systems for natural hazards (NAIAD D7.5 "*European Survey on Insurance Systems and Nature Assurance Schemes*"). It has been developed in three steps: (i) first, a range of key questions identified by the NAIAD project; (ii) information found through a literature review. For those questions without answers or with unclear and/or conflicting answers additional primary new research was performed through (iii) experts' interviews. This survey aimed to capture insurers' current climate risk management approaches at level of the European Union (EU) and the Member State level, which can provide a common baseline from which to build a more detailed analysis and targeted research in the future.

The main expected outputs are: first, a conceptual mapping of the different European Insurance Systems and second, a synthesis on the possible room in these frameworks to

¹ The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party. For instance, insurance (source: preventionweb)

² Premium underwriting is based on an expected claim amount which is determined by analyzing historical data from similar risk (UNISDR 2015). This is combined with: (1) financial losses resulting from the claims, (2) adjustment to cover expenses and to generate profit (Letremy 2009).

³ Retrocession is the purchase of reinsurance by reinsurers.



incorporate nature-based solutions and ecosystem services. NAIAD therefore analyzes the key elements and obstacles to mainstream NBS and ES in the current European insurance systems including people's perception of risks and insurance. This analysis in turn can help to propose new ways to operationalise these concepts by providing the right incentives to promote NBS in risk management and CCA.

The premise is that there is the need for more effective and adaptive instruments to face the increasing frequency of occurrence of natural hazards. NAIAD aims to build a strong pan-European community, enhanced by catalysing the synergies between key actors, such as scientists, stakeholders, and (re)insurance companies. NAIAD seeks particularly to create strategic dialogues on eventual new roles and initiatives by the insurance sector in disaster risk management (DRM) and disaster risk reduction (DRR), to help support the systematic implementations of NBS as a science to policy interaction.

The question posed focuses on: "can we integrate and how the IVE through NBS into (re)insurance policies in the way to support sustainability and resilience of our societies?". The hypothesis to be tested is that NBS are cost-effective solutions that help connect green/blue infrastructures for DRM, DRR and climate change adaptation (CCA). Studies in this scientific domain are insufficiently developed, and thus, NAIAD could help to strengthen the resilience of the partner countries towards extreme weather events and natural disasters. NAIAD will develop standardized tools, concepts and methods to quantify the insurance value of ecosystems through its operationalisation and/or simulation in nine pilot sites (DEMOS), thus, demonstrating the potential applicability and transferability across all of Europe and beyond.

Thus, a group of interested experts were invited to contribute to this research question to help collectively answer these questions as an ongoing conversation on the role of insurance in DRR and CCA, particularly on how the European insurance systems could consider ecosystems as real reliable means to help reduce risks.

3.1 Objectives of the survey

The survey has been based on a literature review. Three documents identified the role and need for commitment by the insurance sector in disaster risk reduction through the use of nature-based solutions. These three documents were: the EU Adaptation Strategy (2013), the Green Paper on the insurance of natural and man-made disasters (2013) and the EU Inventory of Insurance of weather and climate-related disaster risk (Le Den and Kuik 2017). More specifically, the survey aimed to identify different business models for the insurance industry through: (1) revision of the current state-of-knowledge of the insurance industry on NBS; (2) gather stakeholders' global vision on how new business models could work; (3) develop a global vision on the role(s) of insurance in disaster risk reduction.



3.2 Global methodology

The survey has been carried out in three steps.

- In Step 1, the 11 NAIAD countries were selected. These countries provided a comprehensive overview of all EU countries for water-related insurance for different systems and hazards (e.g., floods and droughts). The NAIAD countries included in the survey were: Denmark, Germany, Spain, Slovenia, Poland, France, Italy, Romania, Sweden, the Netherlands and the United Kingdom. Nine countries of the eleven NAIAD countries were already studied within the report (Le Den and Kuik 2017).
- In Step 2, a systematic literature review assessed the current consensus on linkages between the insurance sector, ecosystems and disaster risk reduction. This raised several gaps and ambiguities that were then used to develop a questionnaire to gather this extra required knowledge via interviews. These interviews allowed for qualitative and quantitative comparison of outcomes from various stakeholders.
- In Step 3, interviews were performed in the NAIAD countries to get expert feedback regarding the integration of ecosystems to help reduce risks, and different ways on how the insurance sector could support damage prevention. More than 61 participants, representing a broad range of stakeholders allowed to gather valuable information that NAIAD can build upon for the next steps.

4. Methodological approach

To achieve the goal of this research we adopted a mixed-method approach. This study is based on a worldwide literature review and semi-structured interviews with the European (re)insurance industry and related stakeholders.

4.1 Geographical scope

While countries around the world have experienced natural disasters, the literature review⁴ focused on global publications related to the areas around climate change adaptation, disaster risk management, ecosystem services, nature-based solutions and the insurance industry. The 11 NAIAD countries plus Switzerland were selected as the countries to be covered with the interviews, these countries have contrasting insurance systems that offer a global (re)insurance overview.

4.2 Literature review

In-depth searches were undertaken building on references found during research performed in previous European projects. This highlighted specific keywords such as *“European natural hazard insurance”*, *“insurance and risk reduction”*, *“insurance and ecosystem services”*. Search terms such as *“insurance scheme”* and *“value of ecosystem”* were also used in different

⁴ The objective was to avoid overlapping with the numerous previous (European) projects on these topics.



combinations to further focus, although this rarely yielded articles meeting the inclusion criteria. These searches demonstrated that links between the insurance industry and the concepts of *“insurance value of ecosystem”* and *“nature-based solutions”* are currently in their infancy and not often used or developed in depth in the literature.

Key articles and technical reports⁵ were found in three ways: (1), by changing the terms “natural” for “green” and “nature-based” for “natural infrastructure”; (2) by using following keywords searches on “ecosystem-based disaster risk reduction”, “nature-based solution market”, “ecosystem services and insurance system”, “disaster insurance and nature-based solution”; (3) by using newsletter subscriptions⁶ related to the topic “DRR and insurance & risk transfer”.

4.3 Interviews

The literature review results provided answers but also raised several questions as listed in Appendix 1. These questions helped frame the interviews to understand gaps, needs, challenges and new opportunities in the European insurance sector.

61 semi-structured interviews and written responses were conducted with the European (re)insurance industry and linked stakeholders in order to (1) gather the current state-of-the-art knowledge in the insurance industry on NBS; (2) document a global vision on how new business models could work; (3) have the insurance global vision on their role in disaster risk reduction.

4.3.1 Recruitment of participants

The recruitment of participants and interviews were carried out over the period July to December 2017, by the T7.1 taskforce⁷ and the DEMOs partners.

Recruitment relied on a number of leads: (1) first based on NAIAD partners’ contacts; (2) European meetings related to the insurance sector or water management, such as the CCR Cat day (08/06/2017 in Paris), the World Water Week in Stockholm (29/08/2017), the B3 Meeting (08/09/2017 in Paris), Madrid, etc. and (3), snowballing from interviewees that helped us identify other people relevant to the NAIAD project.

Recruitment emails⁸ were sent to targeted people in 8 identified groups: (1) (re)insurance sector; (2) academic experts; (3) banks; (4) cities; (5) landowners; (6) large project developers;

⁵ Our database gathers 287 thematic-related references. The literature from as early 1986 up to 2018.

⁶ Newsletter subscription is a useful way to ensure a continuous literature monitoring. The NAIAD team is using the UNISDR newsletters: <http://www.preventionweb.net/english/email>

⁷ IRSTEA, CCR, I-CATALIST, SIWI and UPCT.

⁸ The key points of the invitation letter include:

- Benefits of participating
 - Participation will help the NAIAD H2020 project, on the behalf of the European Commission, to develop policies to mainstream the insurance value of ecosystem
 - Participants will have the opportunity to give their opinion/prospective vision on the topic



(7) ministries; and (8) NGOs. These groups provide a broad, balanced and a complementary knowledge to help structure a global overview of the European insurance sector. Not all contacted people agreed to participate.

4.3.2 Semi-structured interviews

We undertook 61 of the semi-structured interviews in person and two of the interviews were completed by email. Interviews included open-ended questions, and some interviewees asked to have the questions in advance.

The literature review combined with the semi-structured interviews facilitated a deeper coverage of the topics, involving the population of interest to help obtain qualitative information to develop preliminary hypothesis (Bogner and W. Menz. 2009, Laforest 2009). Thus, interview questions⁹ sought to examine the participant's perceptions, visions of the interplay risks-NBS-DRR-insurance industry (gaps, needs and opportunities). Not all questions have been answered by all participants for two reasons; first, only relevant questions were posed to the interviewed-target group; and second, to ensure the interviews take around 30 to 95 minutes.

4.3.2.1 Ethical and safety considerations

NAIAD's ethical requirement requires securing suitable informed consent from the subjects to be interviewed. The language used was as far as possible made easily understandable (local and simplified terms rather than technical/scientific terminology). The informed consent forms were developed in compliance with the national and European regulations regarding Personal Data Protection.

This was not a journalistic interview, rather an interview as part of a research project. To ensure the full freedom of expression, data collected during the interview is strictly confidential and only accessible to a limited number of individuals from the T7.1 taskforce. These interviews will never be publicly published. Concerning the recording of these interviews, recordings will be deleted at the end of the analysis.

4.3.2.1 Methods for data analysis

In-person interviews were recorded, translated verbatim and transcribed¹⁰ to facilitate analysis. All interviews (i.e. in-person and email) were analyzed quantitatively and qualitatively

-
- NAIAD will send them directly the outputs (report, synthesis) of the survey.
 - How to participate
 - Participation is strictly voluntary (informed consent form)
 - Participants must participate in the interview by telephone or by teleconference
 - All information provided by the target will be kept strictly confidential and the names of the targets participating in the study will not be shared.

⁹ The questionnaire was available in English, French, Spanish, Dutch, and Slovene. Guideline to help the interviewer to lead the interview have been created.

¹⁰ If the interviews have been performed in the local language of the DEMOs countries, they have been translated in English.



based on the Grounded Theory approach. The Grounded Theory approach was developed in the 1960s by two sociologists (Glaser and Strauss, 1967), and refers to both methods and results.

The Grounded Theory approach is well suited to NAIAD's interview analysis for five reasons:

- (1) First because it gathers interview questions and literature review as background knowledge. The theoretical sampling of literature is necessary to have *"multiple sources of inspiration, ideas, "aha!", experiences, creative connections, critical reflections, and multiple lenses to employ during the research process"* (Brady et al. 2017 p. 419). Both knowledge from the literature review and Grounded Theory helped to have a deeper theoretical framework.
- (2) Second, it is a useful method to analyse qualitative textual data from semi-structured interviews when the need is to broaden the theory/explanation of a process which is currently either in its infancy or non-existent. This is suitable to NAIAD because research on linkages between risks-NBS-DRR-insurance industries are still not very developed.
- (3) Third, Grounded Theory avoids forcing theory into data. Rather, the focus on participant replies helps to see emergent codes/categories/theories that translate the meaning of participants' knowledge and experience. This is necessary because ideally NAIAD' recommendations should be linked to the current functioning of the European insurance industry.
- (4) Fourth, to apply this method, between 25 and 40 interviews were needed with different types of participants. 61 interviews have been performed thus, allowing us to apply the theory.
- (5) Finally, the Grounded theory is a great exercise to find a balance between reductionist approaches to the data and the inclusion of large qualitative data including relevant quotations. Indeed, qualitative data are voluminous¹¹, and thus, being able to manage and summarize these data is the core element of the analysis process.

The Grounded Theory' analysis procedure is composed of two core elements: the coding process; and case-based memos writing. The coding process¹² is based on six precise codification steps (see Table 2 and Appendix 2) to be followed for each interview. At the same time that these codification steps are undertaken, it is necessary to write memos. Memos are made of relevant information/assumptions/linkages/actions gathered during the coding procedures. It is a kind of first analysis of the data. These memos will be used during theoretical coding. Once all interviews are coded, a comparison of categories, codes, among and between themselves is needed. Case-based memos are mixed and compared to the core categories. The last step is the comparison of memos and categories to "in-vivo" coding. Thanks to this continuous comparison

¹¹ An hour and a half of interview can generate 10-15 pages of text.

¹² Coding is the process of naming, highlighting, labelling, sentences and paragraphs to reduce the data to a small set of themes.



(reworking, resorting), theories and memos are “grounded” on the data and reflect the studied phenomenon (Richards 2005). All researchers were convened to discuss the different interpretations to align approaches during meetings.

Table 2: Fundamental components of a Grounded Theory study based on (Saldana 2016)

Code name	Code characteristics	What the code highlights?
“In vivo”	Direct language of respondent + use “quotation”, the terms used by the participants themselves	Action oriented, capture behaviour or processes. Can provide imaginary, symbols or metaphors
“Process coding”	“-ings”, what people do (rather than have)	Actual or conceptual actions – routines, rituals
“Initial coding” or so-called “open coding”	Based on the lines and paragraphs from the data. To code directly from the data and not to forcing data into preconception.	Extractions of relevant concepts (labelling), deeper analysis, being open to selective coding Those codes are grouped into similar concepts. All the codes are gathered within a codebook.
“Focused coding” or so-called “Selective coding”	Frequency and significant codes = to develop categories (larger segment of data)	Highlight major categories and themes from the data (core variable analysis) theory-memos as a basis for the formulation of the final reports
“Axial coding”	To design diagrams of temporal/spatial and cause/effect relationships of the phenomenon (clustering codes into new or more specific codes).	Relationship between categories and codes. Links between one data to another. Comparison Those concepts generated categories which are the basis to write memos (highlight hypotheses about connections between categories, new questions, ideas, relationship between codes. Memos have to be seen as “intellectual workspace for documenting analysis” – all the memos formed a memo banks (Brady et al. 2017 p. 429)
“Theoretical coding”	To find core categories To condensed into a few words that seem to explain, what this research is all about	To identify conflict, obstacles, problem, issue To integrate and synthesize the categories to create new theories. Consequently, all theories are identified and organized allowing for comparison between them and data, theoretical coding

Quantitative analysis has been done only for closed questions and questions with indicators (Appendix 3). Quantitative data has helped to validate qualitative data.



5. Literature review

5.1 Disaster risk reduction, nature-based solutions and insurance value of ecosystems

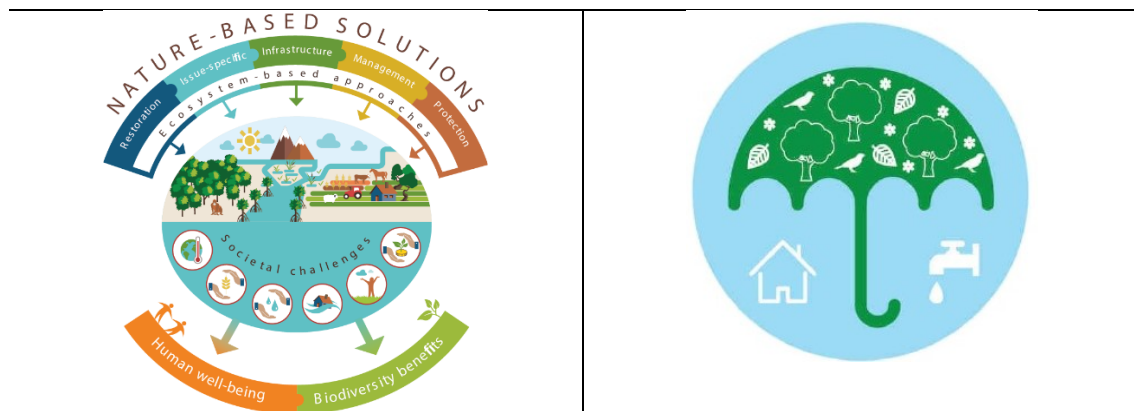
Recently, the climate change debate has moved from a purely scientific circles to an area linked to disaster risk reduction and sustainable development. Following the 2015-fundamental year of policies' activities¹³ and in light of projected climate change impacts, there has been an increased interest in nature-based solutions as ex-ante measures.

In a world and Europe in which we are facing greater uncertainties and natural hazards, a paradigm shift in governments' strategies has moved toward pre-disaster solutions such as green infrastructures. Nature-based solutions are at the heart of these strategies. Nature-based solutions are actions to help societies address a variety of environmental, social and economic challenges in sustainable ways, simultaneously providing human well-being and biodiversity benefits. They are actions which are inspired by, supported by or copied from nature, and which protect, manage and restore natural or modified ecosystems. (Definition based on the European Commission (Nature-Based Solutions & Re-Naturing Cities, 2015) and the International Union for Conservation of Nature (IUCN) (Cohen-Shacham, 2016). The IUCN and the European Commission are two different organisations that view NBS from different perspective and different definitions (Table 3). Both include a link to the insurance value of ecosystem, NBS, disaster risk management, and climate change adaptation.

Table 3: The “nature-based solutions” concept: different perspectives and outcomes
(References: (European Commission 2015, Cohen-Shacham et al. 2016)

IUCN definition	European Commission definition
Actions	Living solutions
To protect, sustainably manage and restore Natural or modified ecosystems	Inspired by, continuously supported by and using Nature
That address societal challenges Effectively and adaptively	Designed to address various societal challenges In a resource efficient and adaptable manner
Simultaneously providing human well-being and biodiversity benefits	And to provide simultaneously economic, social and environmental benefits
Umbrella concept	promotes the use of NBS for enhancing the insurance value of ecosystems

¹³ The Sendai Framework for Disaster Risk Reduction 2015-2030, the COP21 Paris Agreement, the 2030 Sustainable Development Goals.



As early as 1950, General MacArthur saw biodiversity and ecosystems as a form of insurance (Green et al. 2016). This idea to use the term “insurance” applied to ecosystem services has given rise to the concept of “insurance value of ecosystems” Costanza et al. 1989), defining the concept in the nineties, based on research on the natural resource valuation. This “insurance value” is seen as “a metaphor for the societal importance of ecosystems and biodiversity” (Green et al. 2016 p. 2), employed as a “metaphor for keeping an ecosystem in a desirable domain” (Baumgärtner and Strunz 2014 p. 22) and defined as “the system itself having the capacity to cope with external disturbances and includes both an estimate of the risk reduction due to the physical presence of an ecosystem and the capacity to sustain risk reduction” (European Commission 2015 p. 21). The use of the metaphor within the IUCN catchphrase “ecosystems are natural infrastructure that can protect people against hazards”. (European Commission 2015) promotes the use of NBS as solutions for DRR and for the conservation/restoration of the insurance value of ecosystems.

The estimation of the economic value of ecosystems is difficult because of the asymmetry between current direct (services) and indirect benefits (capacity to reduce future the impact of natural disasters). Costanza et al. 1989 highlighted that no one can pay for enjoying or using natural ecosystems which have an uncapturable, invaluable benefits. In addition, the authors have highlighted the social trap issue of both people’s willingness-to-pay for a wetland restoration or maintenance project, and anthropogenic impacts on ecosystems which are not incentivized. (Costanza et al. 1989 p. 15) demonstrate that the storm protection value of wetlands help to reduce tidal surge levels and the wind velocities of storms on land. They have elaborated a “Wetlands Assurance Bonding System”, which deals with uncertainties and imprecision in the data in wetland valuation. The “Assurance Bond” was thought to be used in case of damage, to mitigate environmental damages, to help implement strong incentives to minimize damage to wetlands and help fund research to improve knowledge on wetland functions to be able to calculate precisely the ecosystems’ value. For example, Costanza (1989) estimated a range of values for the coastal wetlands in Louisiana, from \$2.500/ha to \$17.000/ha.



These differences were due to uncertainties and according to the value of the asset behind these areas.

Another author highlights the interaction between levels of biodiversity and ecosystems well-functioning. Protecting biodiversity's redundancy and functions are the best way to maintain ecosystems resilience, in other word, to ensure the long-term *insurance* value of ecosystems (Walker 1992). (Holling. 1986) focuses on the resilience of ecosystems as a concept to understand, guide or adapt to global change. According to the author, disturbances such as fires, landslides, floods, storms are external factors to the ecosystem's resilience: that's why both ex-ante policies to reduce impacts of these natural hazards and ex-post restoration, maintenance measures are needed to help maintain the resilience of ecosystems. On this same line of thought, a number of authors (IPCC 2014a, Team et al. 2014, Kabisch and Bonn 2017), highlight that NBS can reduce climate change impacts. Climate change effects such as more severe droughts, fires, and wind storms can alter ecosystem services¹⁴ composition and thus, increase the risk of losses of ecosystems' functions. Today, The Economic of Ecosystem and Biodiversity (TEEB)¹⁵ aims to evaluate the costs of political inactions in terms of biodiversity and ecosystem services losses, through the Total Economic Value (TEV)¹⁶ (Environment Food and Affairs 2007, Pascual et al. 2010, Sudmeier-Rieux 2013). The potential future use of one ecosystem service (option value), under number of uncertainties, is understood in the TEV, as an *"insurance premium"* or *"as the value of waiting for the resolution of uncertainty"* (Pascual et al. 2010 p. 15).

Today, the worldwide and Europe objective is to work with insurance companies and other actors to *"develop innovative ways for promoting NBS for risk management"* (European Commission 2015).

5.2 European natural hazards insurance business models

5.2.1 General perspective

Understanding the European natural hazards insurance business models is crucial to leverage the industry's contributions to achieve climate change adaptation and disaster risk reduction goals and targets. The last document related to the European insurance systems was

¹⁴ The TEEB and IUCN's ecosystem services classification are: (1) Provisioning services (products obtained from ecosystems); (2) Regulating services (water, air, erosion, natural hazard regulations); (3) Cultural services (benefits for people) and (4) Supporting services (necessary for the production of all other ecosystem services)

¹⁵ The TEEB was created by the European Commission and Germany after the G8+5 Conference of March 2007

¹⁶ The TEV remains: (1) The use value or direct use value: benefits derived from the use of environmental goods such as food, landscape, recreation areas; (2) The indirect use value: benefits provided by ecosystem functions and services such as water regulation, pollution filtering, DRR etc. (3) The option value: the premium placed on maintaining ecosystem services well-functioning for possible future uses not known currently, as a form of insurance (4) The non-use value or bequest value: to future generations / altruistic value: to the current generation / existence value: the willingness-to-pay for their preservation.



published in October 2017 (Le Den and Kuik 2017, P 2017). This report provides the current state of insurance systems. European natural hazards insurance schemes have significant differences from one to the other, in the type of contracts, prices, coverage, and cultural risk and insurance perception.

To put our findings into perspective, first we highlight how these insurance systems work and how these insurance systems vary from one country to another in Europe. (*Note: Appendix 4 provides a more detailed description of the 11 NAIAD countries' insurance schemes*).

To avoid the overlapping with existing numerous references describing the European insurance systems, we had created a “*country fact sheet – do you know European natural hazard insurance system well?*” for each of the 11 NAIAD countries. The objective is to quickly understand how national insurance systems work and how compensation works. The 11 NAIAD countries can be classified – according to the Appendix 4 and the country fact sheets – as **voluntary insurance** (Germany, Italy, Slovenia), **semi-voluntary** (Denmark, Sweden, Poland, the Netherlands and the United-Kingdom) and **mandatory** (France, Spain and Romania).

Most of the NAIAD countries have been studied in-depth in other previous reports (Le Den and Kuik 2017, P 2017). Therefore, only here the Slovenian and the Netherlands' natural hazard insurance systems are detailed here, since these countries were somewhat under-represented in the above-mentioned reports. The choice is to take the same “Attribute table” from (Le Den and Kuik 2017) for the sake of consistency with previous papers.



5.2.2 Country fact sheets

In the following section, the 11 country fact sheets are displayed and the compensation features for each country are briefly commented.

5.2.2.1 *Voluntary insurance schemes*

Germany

The State coordinates large scale preventive measures (cross border) while the Bundesländer are those in charge of building and maintaining them. The risk-based premium is normally calculated without individual preventive measures in mind (there is no obligation for insurance companies). If the homeowner has done something to prevent the loss or lower the loss, he will get a discount and/or a lower deductible¹⁷.

To receive compensation after disaster losses, the citizens and businesses must be insured through private insurance companies. If they are not insured, citizens and businesses will not receive compensation and have to cope with the losses from their own resources to restore their assets. The State does not compensate in case of disaster beyond the emergency aid (like large scale events during the 2002-2013 flooding).

Italy

Whether citizens are insured or not, after an official declaration of “disaster”, citizens (and small businesses) will receive an ad-hoc compensation from the “National Solidarity Fund” of the State. This official declaration of “disaster” does not follow a fixed framework but is based upon on political/flexible/subjective motivation. The amount and the identification of covered damages is different from time to time but, especially for earthquake event, usually almost all public and private damages are covered, even if they are insured.

If the event is not recognized as a “disaster”, non-insured people have to cope with the damages from their own resources. Insured people will rely on a compensation based on their policy. In case of an earthquake event, the European Solidarity Fund is unlocked, to cover uninsured damages. The relationship between insurance coverage and public damage restoration creates an inverse selection: there is no incentive to prevent or reduce risks (even with an insurance policy) as there is a coverage of last resort.

Most Italians think that the State has reimbursement obligation and that they are not at risk, although 78% of households are at risk (35% are exposed to earthquake, 55% are exposed to floods). Italian insurance companies lead prevention, raise risk awareness and DRM. The current penetration rate is 2%¹⁸ (Farina n.d., ANIA 2017a) and there is a strong North/South differentiation for natural hazards coverage (maps p5-6 (ANIA 2017b)).

¹⁷ Information collected from the German Insurance Association.

¹⁸ In 2016, 435000 houses were covered for natural catastrophes (188,000 for earthquake, 185,000 for flood and 62,000 for both earthquake and floods). In 2009 only 35,000 houses were insured (ANIA 2017b).



Norway

What is considered a natural hazard is defined by law. This is river floods, storms, landslides, storm surge, and volcanic eruption.

However, damage due to flash flood/storm water/pluvial floods and sewage back-up in cities are not considered a natural hazard and an “act of God”, but damage due to insufficient capacity in the (water and sewage) infrastructure or maintenance. This type of hazard is in Norwegian called “overvann” which indicates the water collects on the surface.

Losses due to “overvann/urban flooding” are covered by the property insurance with a risk-based premium, and not part of the Norwegian Peril Pool. Finans Norge highlights that the insurance compensation costs for these losses exceeds the compensation cost for all the natural hazard losses¹⁹.

The Norwegian Natural Peril Pool (NNP) was established in 1980²⁰. Insurance companies offering fire insurance in Norway are required to be a member of the pool. The main task of the NNP is to regulate monthly the members/insurance companies to never pay more than their market share of a natural disaster event. It means that when a disaster strikes, the companies pay the claims to the policyholders and then send their compensation/payouts to NNP which will either pay or ask for money.

The natural hazard premium is part of the property insurance premium collected by the insurance company, and the claims are paid by the insurance company. Meaning, the insured does not really “notice” the compensation system, other than they must pay around the double in self-insured retention (€100). It is a solidary system, regulated by law. The premium is “flat”, set by the pool and to a promille of the fire insurance sum (today 0,07). Personal and commercial/industry buying fire insurance pay the same premium rate. Regulated by law, the insurance company shall only pay losses up to the market share. The companies therefore, will either receive or have to pay after an event. The role of the pool is to equal out all claims amongst the members of the pool. The company can, by law, shorten the payout if the property was very bad maintained and there more damaged.—. The pool is buying reinsurance “on behalf” of the companies. When there is a major flood or natural hazard event, the pool decides if they or each insurance company individually, should organize the loss adjusters.

Municipalities and cities are responsible for the maintenance of the infrastructure and water and sewage system being sufficient enough for the day to day weather. After disaster strikes, insurance companies need to look at the main cause of the hazard to declare if it is a natural hazard or a urban flooding/overvann.

If they believe the damage is due to an insufficient infrastructure they will send the bill over to the “polluter”, the municipality.

¹⁹ <https://www.finansnorge.no/statistikk/skadeforsikring/klimarelaterte-skader/hovedoversikt-klima/>. Finans Norge has started to collect “water related” claims (not natural hazard claims) from the companies in 2008.

²⁰ <https://www.naturskade.no/en/>



The pool has no mandate working with preventive measures. The natural compensation system has been criticized for giving no, or few incentives for the insured and for land use planning, to invest in preventive measures, as this will have no effect on the cost of insurance premium or the outcome of how much is compensated.

Slovenia

Overall description

Slovenia is an example of voluntary insurance coverage. For instance, flood, storm, earthquake, hail, are insured on a voluntary basis (optional bundled coverage²¹). The Slovenian citizens rely on the post-disaster State fund that provides compensation. After disasters strike, the assessment of direct damage and a proposal for recovery shall be submitted by the Ministry competent for protection against natural and other disasters to the Government. When the use of disaster recovery funds have been decided, the direct damage losses have to exceed 0.3% of the annual planned budget revenues (Law on the Elimination of Consequences of Natural Disasters, 2003²²). In Slovenia, all who are affected by a natural disaster event have the possibility of compensation regardless of their insurance coverage situation. However, the current Slovenian risk management is characterized by a high degree of uncertainty as victims cannot rely on sufficient governmental compensation if losses do not exceed 0.3% of the budget. To assess the losses well, a Decree on the Damage Evaluation Methodology (no. 63/03 of 2003), carried out by the Administration for Civil Protection and Disaster Relief (ACPD), has been implemented to determine the damage losses and who is responsible for the assessment:

- Damages to cultural heritage structures: Ministry of Culture
- Damages to watercourses: Slovenian Environment Agency
- Damages to State roads and energy industry: Ministry of Infrastructure and Spatial Planning
- Damages to forests: Slovenian Institute for Forests

In addition to this State budget allocated to ex-ante compensation, the State has a budget dedicated to data collection. It is a uniform multi-hazard loss database solution for the municipalities to collect high quality data and to collect it into a national database, called AJDA. The Insurance Supervision Agency (Agencija za zavarovalni nadzor, AZN) is also highly involved in risk reduction (e.g. insurance conference “Consumer protection in new area, innovation vs. regulation”²³).

²¹ <https://www.zav-zdruzenje.si>

²² Official. Gazette of the Republic of Slovenia, 75/2003, <https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina?urlurid=20033620>

²³ “Consumer protection in new area, innovation vs. regulation”, conference in Ljubljana in September 2017 in the objective to improve knowledge and products thanks to new digital tools and to new regulatory changes.



Slovenia has an insurance sector that is quite less developed than in other European countries (the penetration rate is 5.1% per GPD where 0.30% for fire and natural forces insurance coverage) vs. 7.6% on average across the EU). The Insurance Act (Zzavar-1 and Zzavar) came into effect on January 2016. Under this Act insurance companies should cover natural hazards: storms and natural forces other than storms – article 7 “insurance business”, §2 (8), setting high solvency requirements (article 104, “risk management”) and use the reinsurance (article 2, “insurance business”). In Slovenia, there is both presence of international companies and local Slovenian insurance companies (e.g. Triglav, Adriatic Slovenica).

Private market insurance coverage against losses resulting from natural hazards provide coverage and compensation based on the policy. For example, most insurance companies cover for damages to private buildings up to a sum of between €30,000 and €60,000, compensating the sum insured according to the policy, and deductibles based on the sum insured (Triglav Group 2017).

Fire and natural forces comprise 5.86% in 2015 of the total insurance premiums in 2015 within the Slovenian companies, with a claim ratio of 45.21% in 2015. Concerning the reinsurance premiums dedicated to fire and natural forces, the amount is 42.1% in 2015 and it is the highest proportion of reinsurance premiums (Slovenia Insurance Association 2016).

There are very few products dedicated to cover losses from flood, earthquake, storm or drought events. In some cases, insurance companies refuse to cover farm lands.

Attribute table for Slovenia

ATTRIBUTE	SECTOR		
	Household/Building	Commercial	Agriculture (crop)
Name, year of establishment	N/a		
Hazard(s) covered	Floods; Landslide; Avalanche; Earthquake; Hail; Droughts		
Official trigger Yes / no Description?	Yes if the losses exceed 0.03% of the national budget income/year and if the government approves		
Type of insurance, e.g. bundled, parametric triggers	Bundled indemnity insurance		
Compulsory vs. voluntary	Voluntary		
Damage covered	Damage to buildings and contents		
Limit of compensation	In theory none: average coverage in 2017: ~€60.000 (average claim paid ~€1.375 in 2015)		



Individual deductibles	policy	Based on the sum insured;		
Risk Reduction Incentives based on: Premiums Deductibles Other		/		
Market penetration rate		Earthquake and flood: 50% Storm: 90%		
Premium setting rule, e.g. risk based, flat, fixed percentage of insured value?		Premiums are not dependent on risks.		
Reinsurance access: Private reinsurance Public reinsurance		Private reinsurance (in 2015 the total reinsurance claim pay-out was €144.7m)		
Average annual premium		~€165		
Access to public disaster response fund		Yes if the losses exceed 0.03% of the national income/year.		
Pay-out speed		/		
Additional comments		Developed multi-hazards loss database (AJDA database) at the municipality scale. Detailed role of each stakeholders in damage assessment (Decree on the damage evaluation methodology). The EUSF is also available.		
References: (Maccaferri et al. 2012, De Groeve et al. 2014, Gizzi et al. 2016, Slovenia Insurance Association 2016, Triglav Group 2017)				

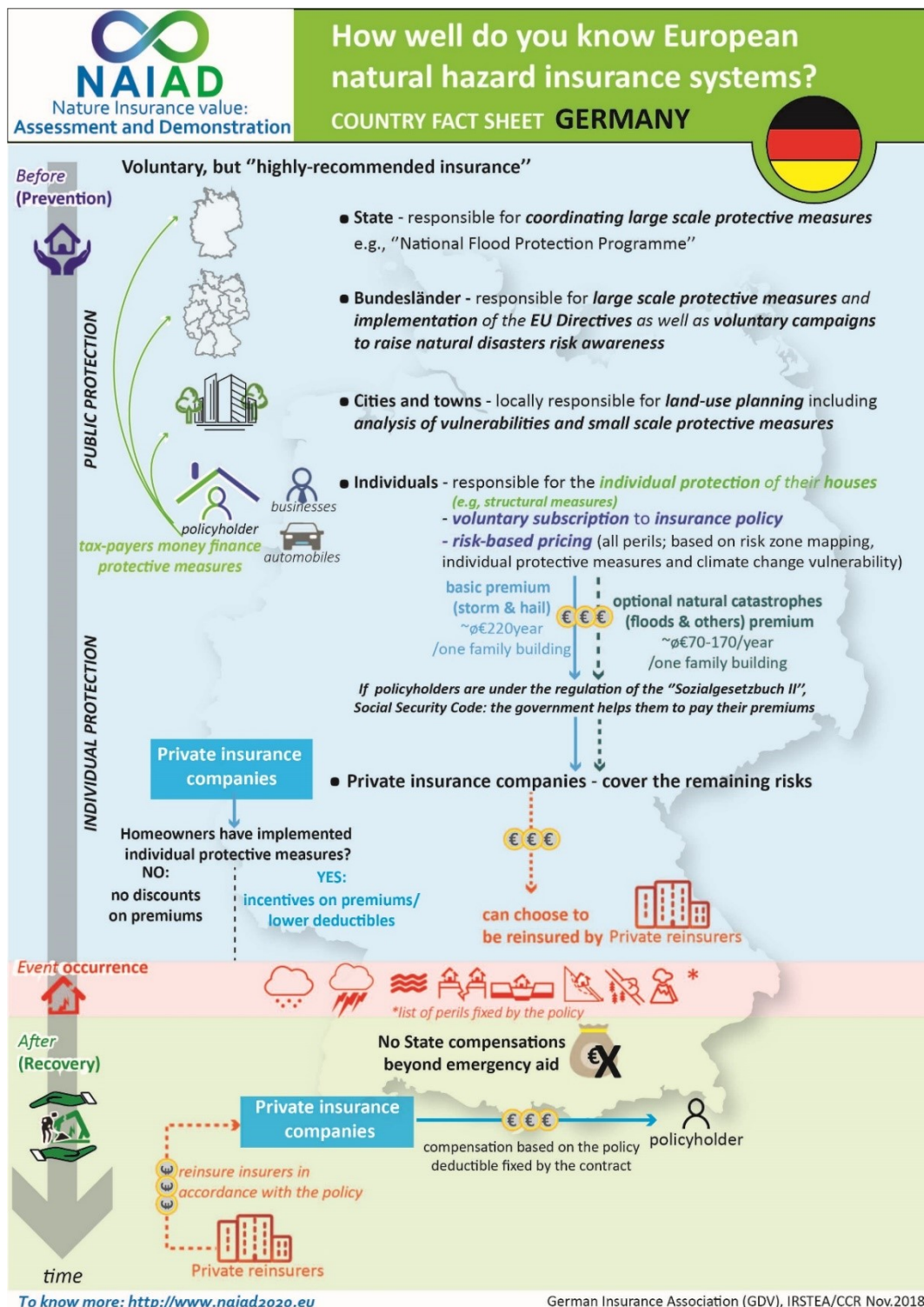


Figure 1: Country fact sheet for Germany

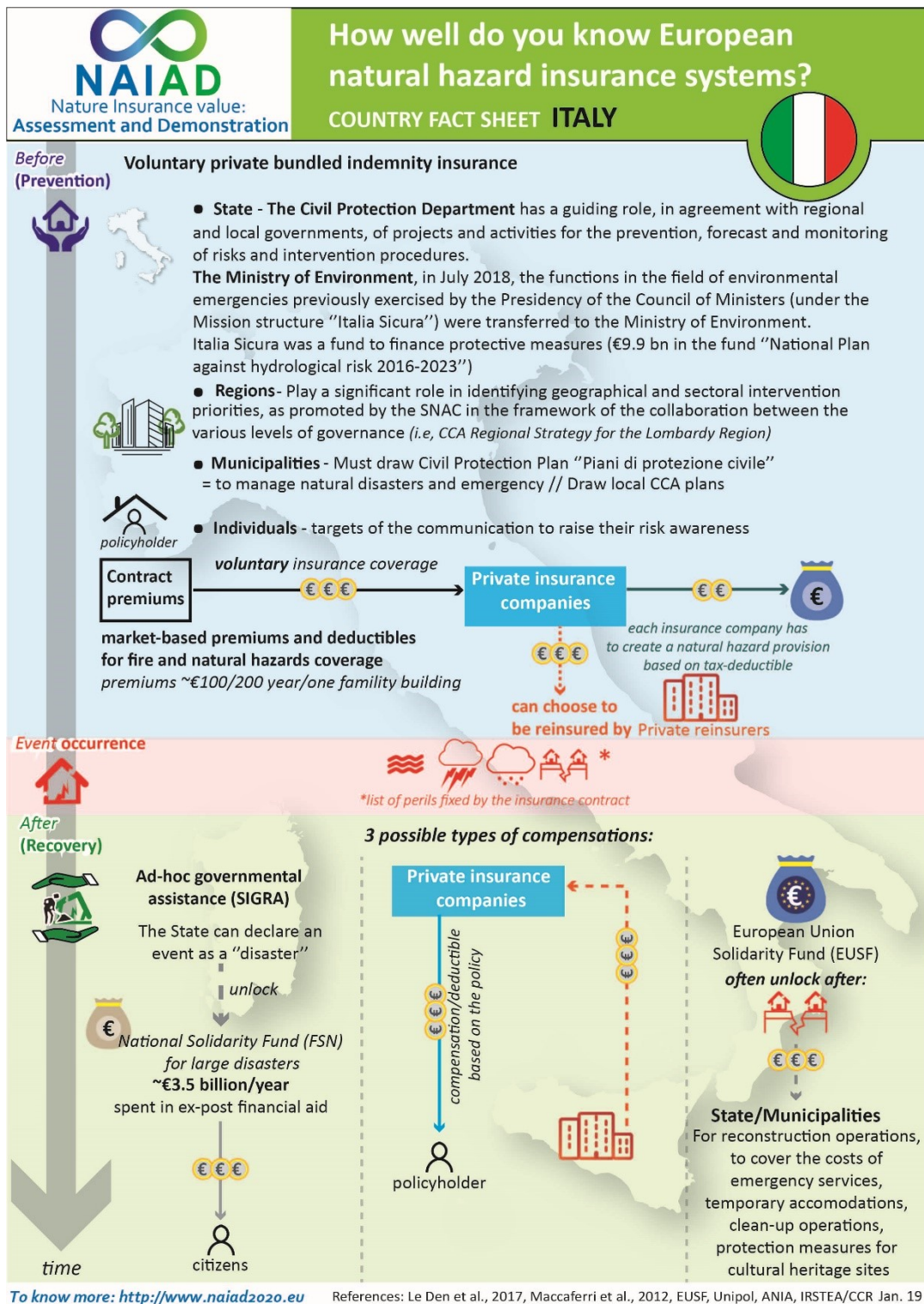


Figure 2: Country fact sheet for Italy

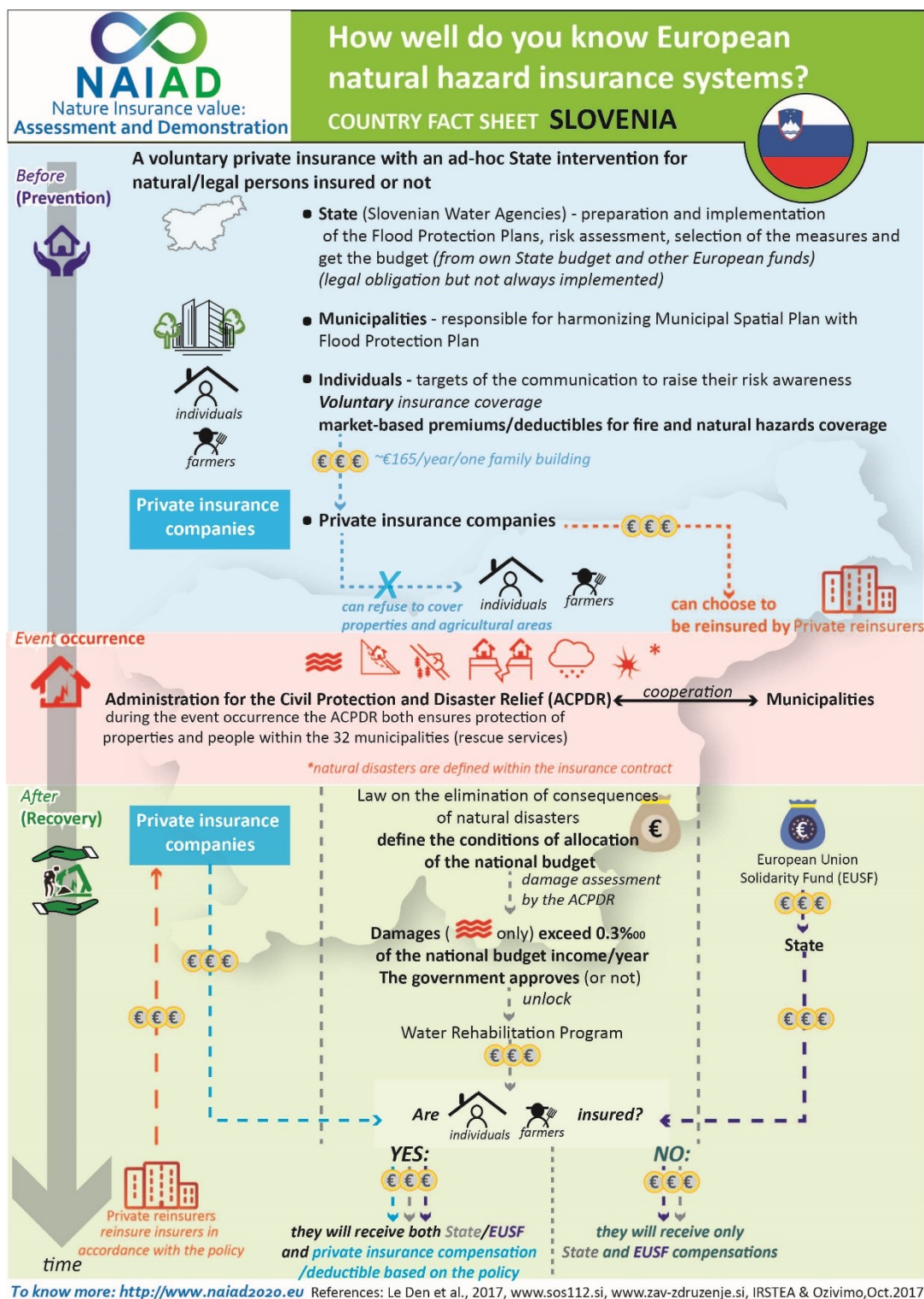


Figure 3: Country fact sheet for Slovenia

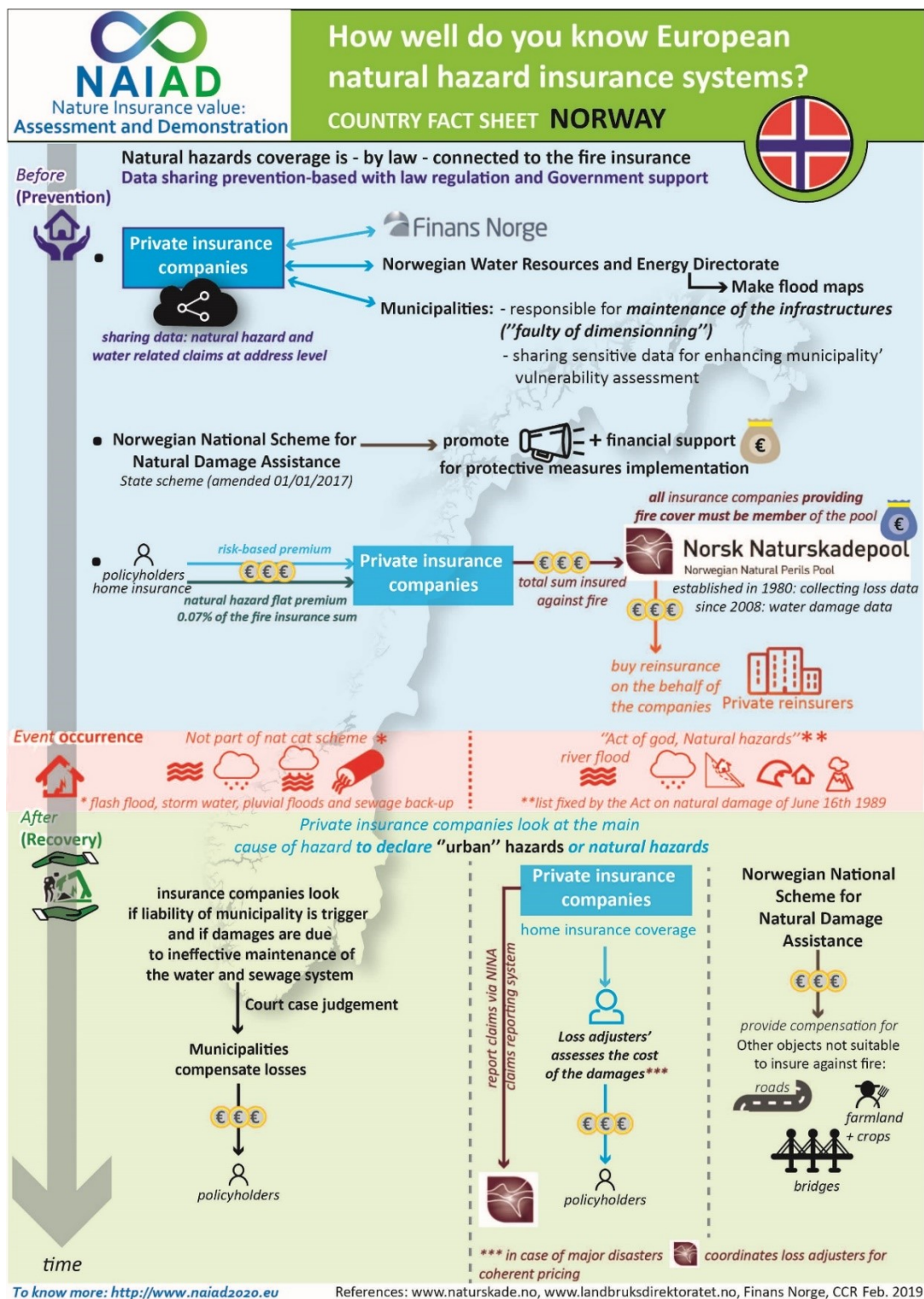


Figure 4: Country fact sheet for Norway



5.2.2.2 *Semi Voluntary insurance schemes*

Denmark

The Danish Storm Council (DSC) recognizes three types of natural disasters to unlock compensations: Storm surge, Flooding and Windfall. These natural hazards are not covered by private insurance companies. Instead, there is a tax on all fire insurance policies of annual tax of 60 DKK/policy. This tax goes to the fund 100%.

If a storm surge or flood strikes and it is recognized as a “20-year events or over” by a DSC declaration, the DSC fund is unlocked to compensate insured property owners both private and business if they make a request to the DSC. The claims adjuster from policy owners own private insurance company assesses the cost of the damages; and the company decides what is covered by the DSC fund. If the storm surge or flood is not recognized by the DSC, they damages is not normally insured by the private insurance sector. The citizens can in most cases with storm surge and flooding therefore only rely on a compensation given by the DSC. In the case of windfall strikes forest owners, they must be insured against storm damage to trees for their entire property to have the DSC compensation.

Sweden

The Swedish natural hazards insurance scheme is a semi-voluntary one. Natural catastrophe insurance coverage is a mandatory mortgages requirements for houses/villas (the penetration rate is about 99.5%). Concerning individuals/consumers, natural hazard protection scheme is included in all household insurance, about 97% of all households have such insurance. The premium is a result of all risks within the cover of the household insurance. In case of natural hazards (forest fire, cloudburst, storm, storm surge, snow pressure and floods), citizens/commercial/industrial have to be insured to be compensated. There is no public settlement scheme and no State aid to cope with the losses. The Swedish insurance industry has precise definitions/thresholds of natural hazards to unlock reimbursements – Table 4.

Table 4: Natural hazard definition by Swedish insurance companies

NATURAL HAZARD	THRESHOLD
Cloudburst	Water must enter into the house from the ground floor in order for the insurance to cover damage More than 30mm rain within 30 min
Forest fire	Damage to house: simple house insurance coverage Damage to property land: wildfire insurance coverage
Storm surge	110cm above normal water surface Warning starts from 80cm
Storm	Wind speed of more than 21m/s
Snow pressure	Will be compensated if the building has been built according to relevant building rules in the zone the building is located



References: Danish Insurance Association et al. 2013, Swedish Civil Contingencies, Insurance Sweden

It is important to bear in mind that the thresholds below, for natural hazards may vary between the Swedish insurance companies. There is no common decision on the limit of the thresholds even if most of the insurance companies uses the mentioned thresholds in Table 4.

The State allocates fund dedicated to preventive measures (i.e., 40 million Swedish kronor per year). There is a PPP between the Insurance Sweden and the Government Financing Swedish Environmental Institutes for implementing preventive measures. Premiums are risk-based, premiums can be decreased if preventive measures are implemented. This mechanism works especially for commercial and industrial and not so much for individual. Municipalities are responsible for water services, dimensioning and maintenance of the pipes, there is a strict liability if responsibility is established, in that case municipalities will have to compensate the damages.

The United-Kingdom

In case of flood or storm event, to be compensated the citizens must be insured. There is no State aid to cope with the losses.

Flood Re is a joint initiative between the UK Insurance industry and the UK Government established in 2016 to improve the availability and affordability of household insurance for people who live in high flood risk areas. It enables insurers to choose to cede policies to the scheme, for which they pay Flood Re a below-market rate premium – meaning the insurer can offer the householder a lower price. Flood Re then ultimately covers the ceded property in the event of a flood. To be eligible for ceding a policy must cover a domestic home that was built before 2009. Over 90% of the UK home insurance market have signed up to the scheme and more than 150,000 policies are ceded to the scheme.

Concerning protective measures implementation, the Department for Environment, Food and Rural Affairs (DEFRA) is the lead Government department on flood policy and provides funding for FCERM (Flood and Coastal Erosion Risk Management) projects. The Government published a National Flood Resilience Review in September 2016 which assessed how the country can be better protected from future flooding and increasingly extreme weather events and committed to publish a 25-year environment plan which was expected to include an integrated approach to flood risk mitigation. The Government committed to investing £2.5 billion in capital funding for flood defences for the period 2015-16 to 2020-21, stating that the six year investment would protect a further 300,000 properties and reduce flood risk by 5 per cent²⁴. Previously funding was allocated on an annual basis only.

²⁴ Flood risk management and funding in the United-Kingdom, <https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7514>



The Netherlands

Overall description

The Netherlands have a national policy to not have a flood insurance coverage. In the 1950's Dutch insurers made a binding agreement in which insurers decided to no longer provide flood insurance since the damages would exceed their capacity to compensate. Later, attempts have been made to reinstate flood insurance policies since risks have decreased massively thanks to major flood management solutions. However, these attempts have failed since the government and insurers have not reached consensus. Insurers wanted more support from the government and a mandatory insurance for citizens. As a result, nearly all insurers do not provide flood and earthquake insurance policies, even though insurance companies are free to do so.

In 1998, the Dutch government has accepted a new law, which provides the government the possibility to grant compensation in case of national disasters, namely flooding by freshwater, earthquake or "at least other disaster of comparable order" (defined in the Article 1, Security Regional Act²⁵). The ad-hoc reimbursement is organised in the "Wet Tegemoetkoming Schade bij rampen" (WTS, Calamities Compensation Act, CCA). This is not a fund, it is a "State reimbursement", "a safety net scheme", its means that it is not a full compensation for property damage. The WTS is only dedicated to people have implemented preventive measures or suffered property damage and only applicable for damage that is uninsurable, unavoidable and non-coverable.

This aid is unlocked only after a decision of the Ministry of Justice and Security by Royal Decree on whether the disaster qualifies for this compensation (Law to compensate damage in case of disasters²⁶). Storm damages are excluded from the WTS. If the CCA is applicable, the Ministry of Justice and Security has to draw up a ministerial regulation including: extent of the damage area; categories of damage and costs eligible for an allowance; the level of allowances; and applicable procedure. Then, the CCA aid are unlocked for restoration and reconstruction.

The maximum State aid that can be provided through the WTS is €450,000,000 per year. The State compensates losses through the WTS which is funded by general tax money. Please note it is not a specific tax because it is not a fund. However, the current Dutch risk management is characterized by a high degree of uncertainty, since victims cannot rely on well-defined criteria to assess damages and the amount of compensation.

To date, it is possible for homeowners, tenants and businesses to be flood-insured on a voluntary basis by private insurers under "Neerlandse²⁷" underwriters of the Lloyds and

²⁵ Law Security Regions, <http://www.wetten.overheid.nl/BWBR0027466/2017-06-10>, the target of the scheme is: citizens, businesses, government, churches, associations, foundations & agriculture.

²⁶ Law to compensate damage in case of disasters, [http:// www.wetten.overheid.nl/BWBR0009637/2016-01-01](http://www.wetten.overheid.nl/BWBR0009637/2016-01-01)

²⁷ Neerlandse, <http://www.neerlandse.nl>



reinsured by the private market. Premiums are risk-based according to the dike-ring area. Policyholders are eligible for a discount of 5% in return for taking one of two possible protective measures²⁸. Storm-risk insurance is an optional coverage, an extension of the property policy (fire, thefts etc.). As mentioned above, if Dutch citizens are insured by private companies, the WTS compensation is not accessible. Thus, in case of a disaster, the private insurance sector offers security of compensation; the WTS does not since there are uncertainties first, on whether the damage will be recognized as a “disaster” and second, on the amount of compensation provided by the State. The current penetration rate is <5%.

²⁸ The two protective measures are: 1/ cofferdam in front of houses; 2/ sand bags; Information gathered from Neerlandse.



Attribute table for the Netherlands

ATTRIBUTE		
	Household/Building	Commercial
Name, year of establishment	"Wet Tegemoetkoming Schade bij rampen" (WTS, Calamities Compensation Act, CCA) – 1998 Neerlandse - 2012	"Wet Tegemoetkoming Schade bij rampen" (WTS, Calamities Compensation Act, CCA) – 1998
Hazard(s) covered	Floods; Earthquake; As defined in article 1 of the Security Regional Act Neerlandse covers floods, earthquakes, hail, snow, frosts	Floods; Earthquake; As defined in article 1 of the Security Regional Act
Official trigger Yes / no Description?	Yes, Royal Decree to recognize the disaster	Yes, Royal Decree to recognize the disaster
Type of insurance, e.g. bundled, parametric triggers	No flood insurance Neerlandse: bundled	No flood insurance
Compulsory vs. voluntary	No flood insurance Neerlandse: Voluntary	Voluntary
Damage covered	CCA and Neerlandse: Damage to buildings and contents (person injury not covered)	Damage to buildings and contents (person injury not covered)
Limit of compensation	/ Uncertainty on the amount of the compensation from the CCA Neerlandse: compensation based on the policy (~€75.000)	/ Uncertainty on the amount of the compensation from the CCA
Individual policy deductibles	Deductibles fixed by the State Deductibles fixed by the contract	Deductibles fixed by the State
Risk Reduction Incentives based on: Premiums, Deductibles, Other	/ Neerlandse: 4 measures can provide 5% discount premium each	/ Neerlandse: 4 measures can provide 5% discount premium each
Market penetration rate	<5%	<5%
Premium setting rule, e.g. risk based, flat, fixed percentage of insured value?	No premiums Neerlandse: risk based premium	No premiums Neerlandse: risk based premium
Reinsurance access: Private reinsurance Public reinsurance	State as reinsurer Neerlandse: Private reinsurance	State as reinsurer Neerlandse: Private reinsurance
Average annual premium	No premium Neerlandse: ~€200/month	No premium Neerlandse:?
Access to public disaster response fund	Yes, if the disaster is recognized (not accessible for insured people)	Yes, if the disaster is recognized (not accessible for insured people)
Pay-out speed	/	/
Additional comments	Lot of uncertainties for the homeowners on the amount they can receive from the CCA in case of disaster. Ongoing discussion to implement a PPP flood insurance scheme.	Lot of uncertainties for the homeowners on the amount they can receive from the CCA in case of disaster. Ongoing discussion to implement a PPP flood insurance scheme.

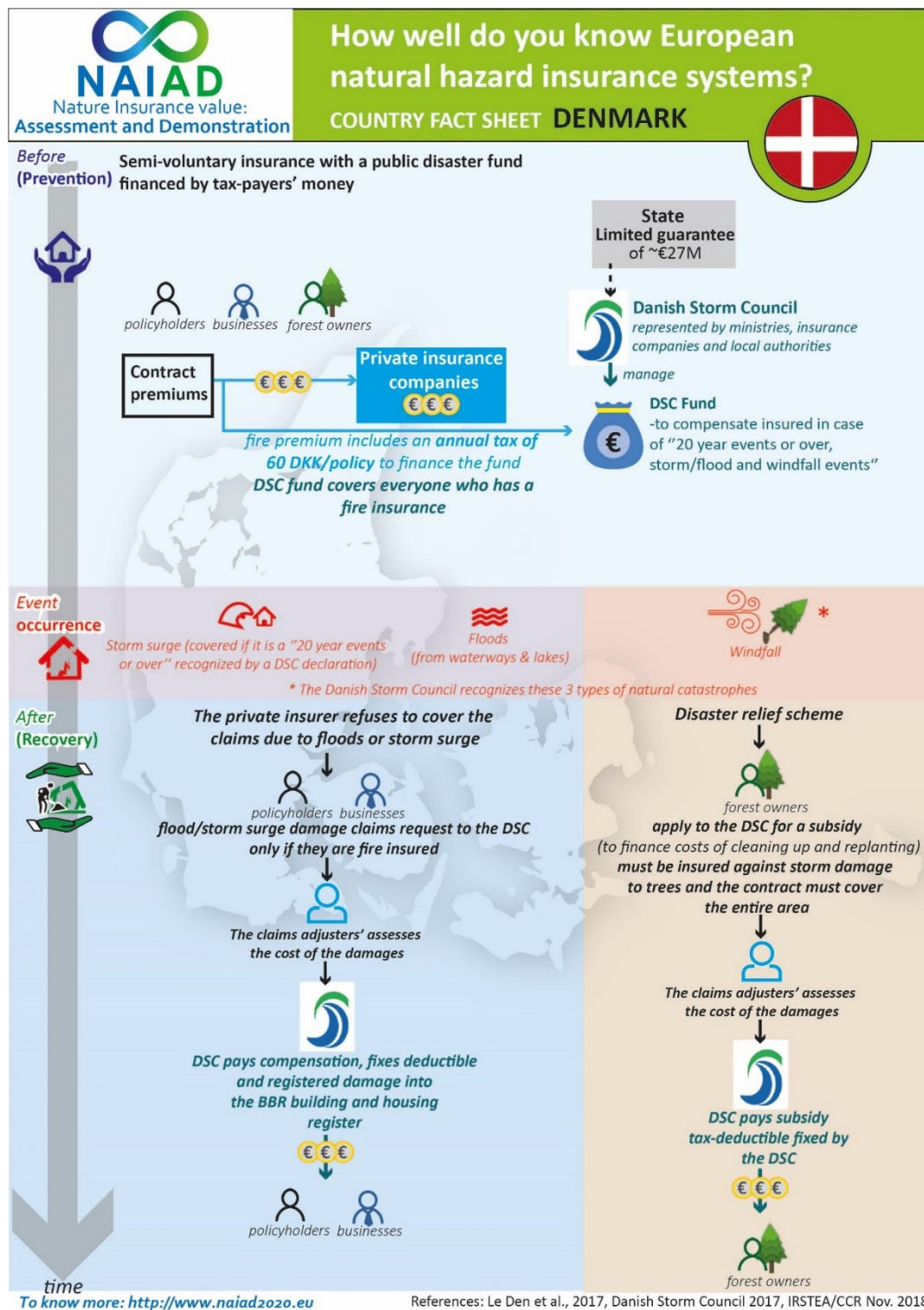


Figure 5: Country fact sheet for Denmark

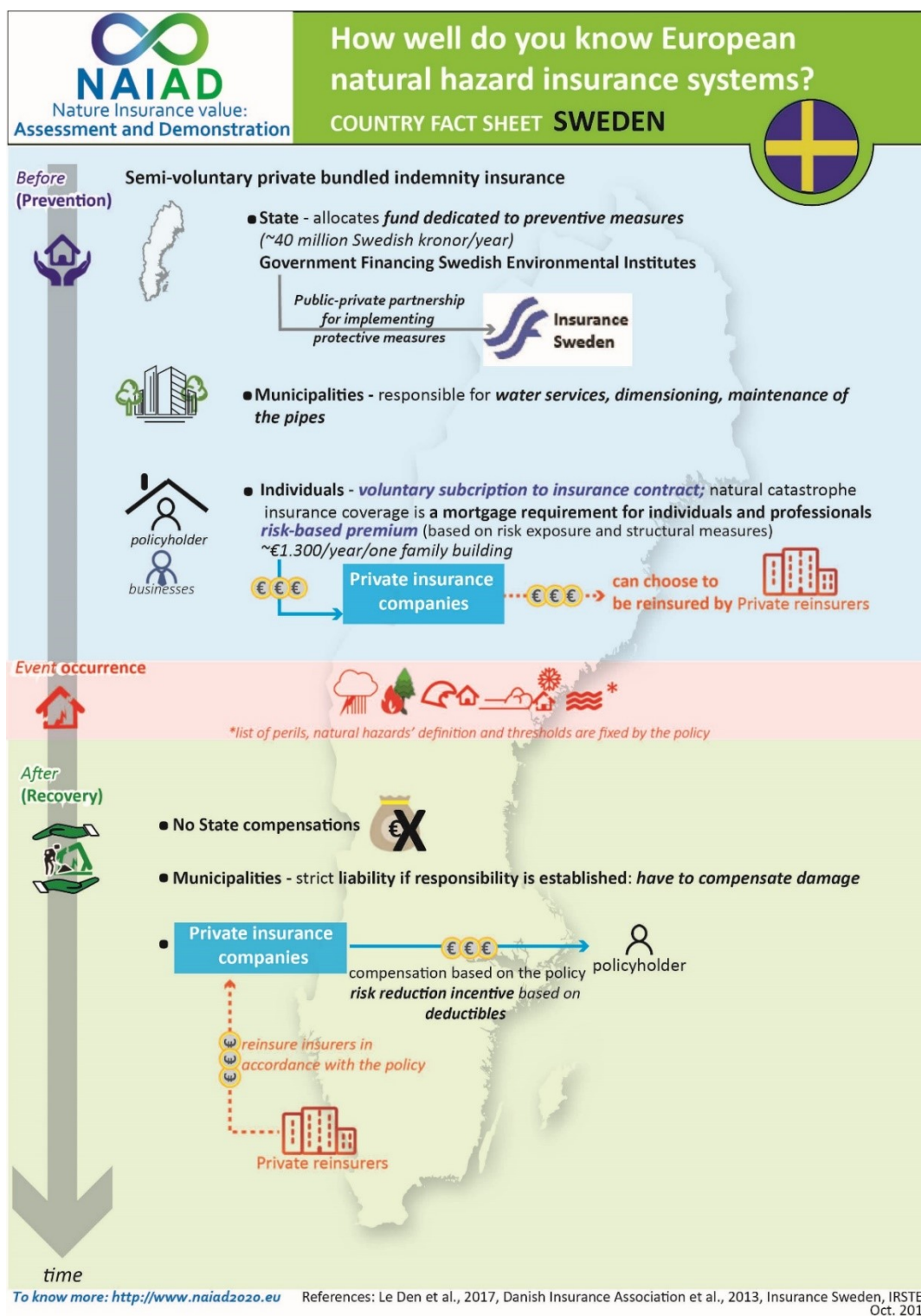


Figure 6: Country fact sheet for Sweden

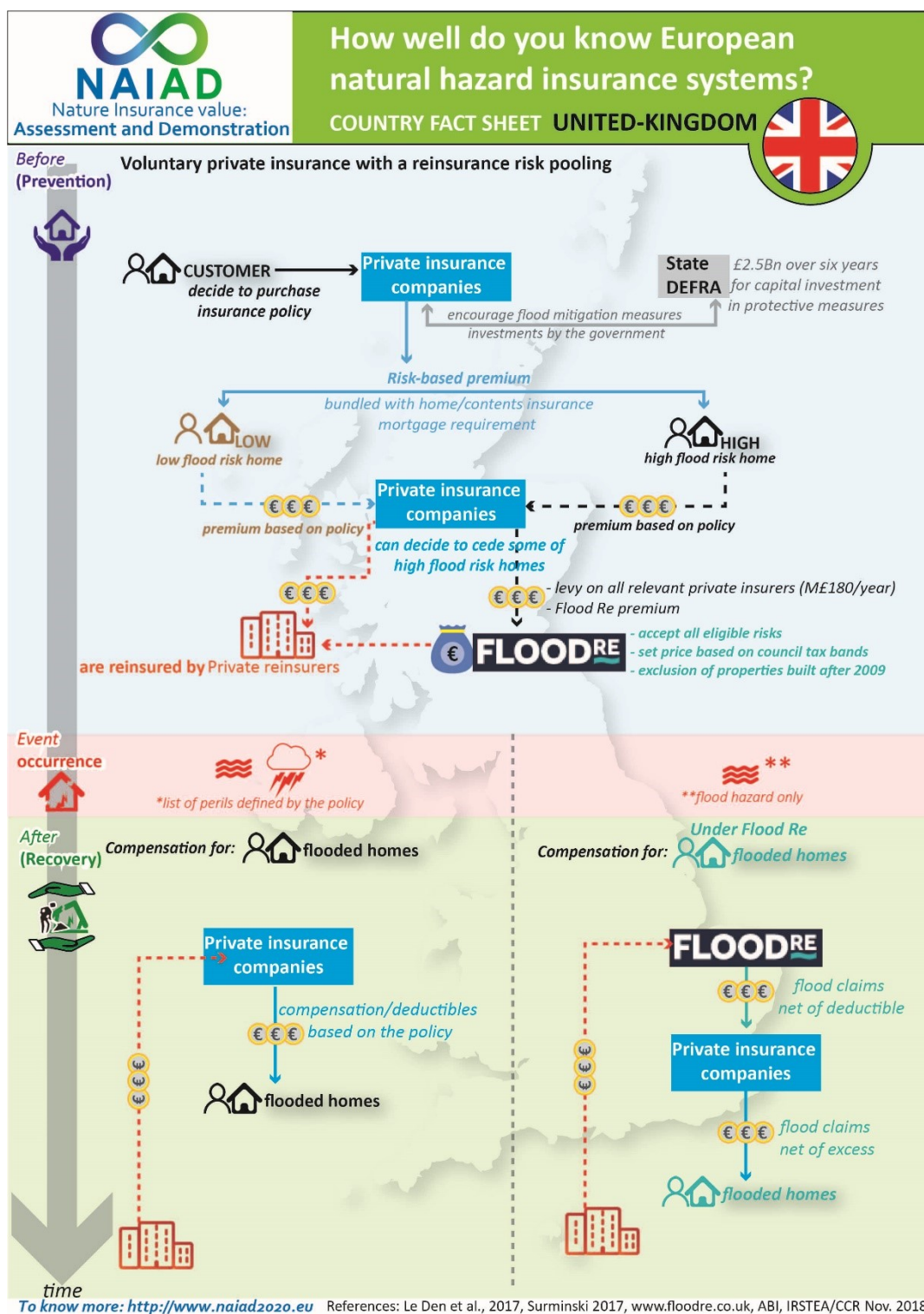


Figure 7: Country fact sheet for United-Kingdom

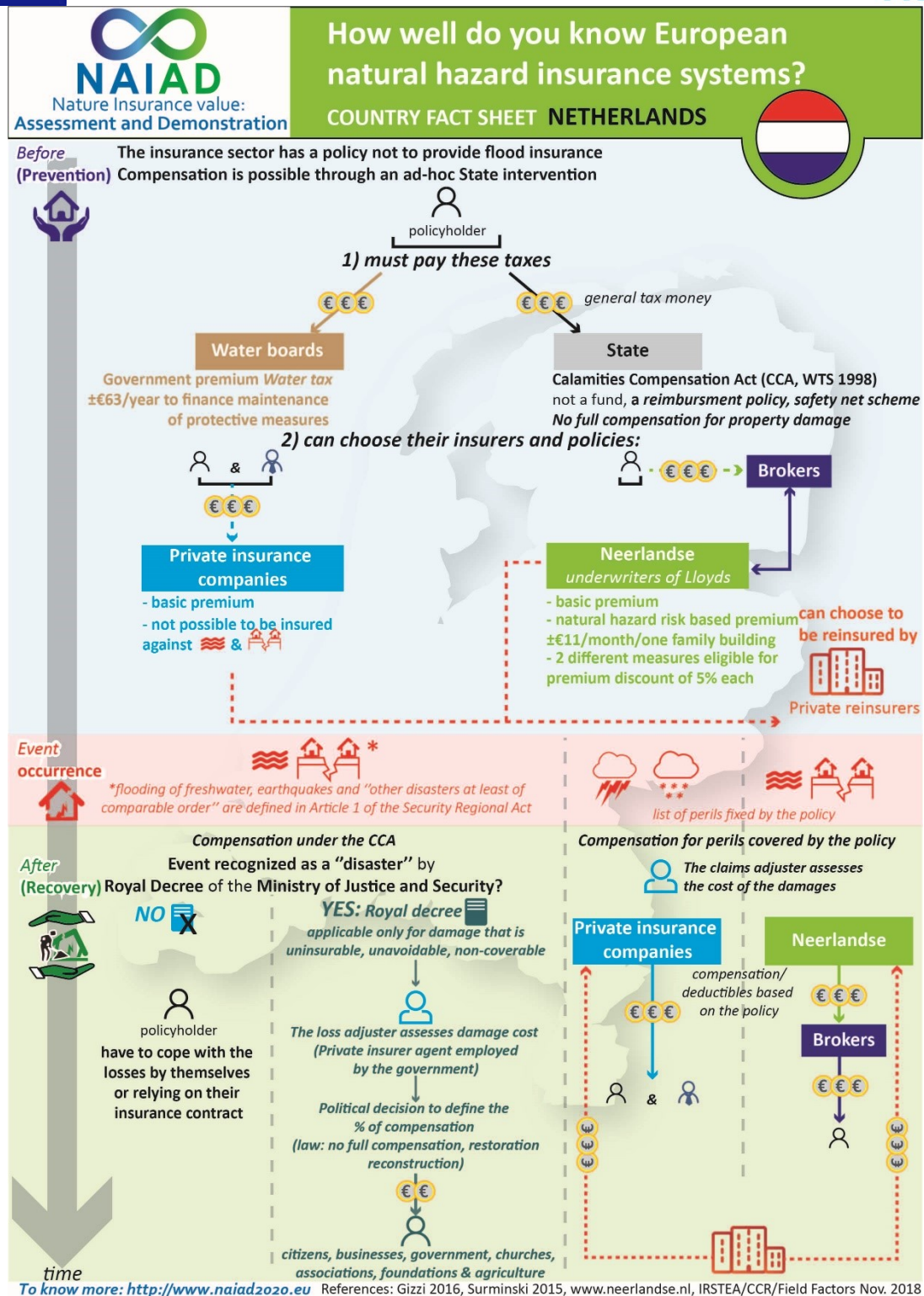


Figure 8: Country fact sheet for Netherlands



5.2.2.3 *Mandatory insurance schemes*

In France and in Spain the Cat Nat coverage is mandatory for everyone who has a damage insurance. But the damage insurance is not mandatory. Thus, in the overseas territories, only a part of the population has Cat Nat coverage. In Spain, when you get a loan to buy a house, the bank forces you to pay for a house insurance. In Romania, NatCat coverage is mandatory for everyone otherwise, it is punishable from 100 to 500 lei (€20 - €100).

France

There are two types of natural hazards coverage in France:

- Covered by classical insurance products: windstorms, hail and snow.
- Covered by the national Cat Nat scheme: floods, droughts, storm surge, earthquakes, cyclonic winds in the overseas territories etc.

If a natural hazard occurs and only if this hazard is recognized as a “natural disaster” -- by a governmental decree (Law of the 13th July 1982) “Cat Nat”, the “CatNat” compensation is unlocked (deductibles are then fixed by the law -Figure 30). The “Cat Nat” insurance premium is calculated as a flat rate (12% for non-motor and 6% for motor insurance based on the damage insurance premium). The Cat Nat coverage is mandatory for all the damage insurance contracts (motor, residential, agricultural, industrial and commercial) but the damage insurance is not mandatory. In the Metropolitan France, nearly 100% of the population has a Cat Nat coverage. In the overseas territories, the diffusion rate is significantly lower (~50%). The claims adjusters’ will assess the losses for each policyholder located in the areas defined in the decree (commune level) and concerned by the natural hazard. After that, the private insurance companies will compensate/indemnify the insured. If the natural hazard is not recognized as a “natural disaster”, the Cat Nat insurance coverage will not work but a private insurance contract may cover the damages, based on the policy choice by the policyholder. As the insurance coverage has a large diffusion rate in France, everyone is covered in case of disaster, with an exception for the overseas territories. The insurance companies can choose to be reinsured by CCR (French public reinsurer proposing State Guarantee with an unlimited coverage) or by the private market. Some insurance companies also make the choice to have no reinsurance for Cat Nat losses.

Spain

In Spain the Consorcio de Compensacion de Seguros (CCS) has made two classifications of natural hazards:

- Extraordinary risks such as floodings, extreme winds events (>120kph) and tornados.
- Non-extraordinary weather events such as hail, landslides and windstorm (<120kph).

The insurance coverage extension for multiperils is a compulsory element of insurance policies, there is no legal obligation to buy a general insurance policy.



Private insurers provide non-extraordinary weather events coverage and compensations based on the policy. If an “extraordinary risk” strike - according to the list fixed by the CCS - the CCS compensates policyholders directly. The Consorcio is not a reinsurer, but act as an insurer: it manages claims, sends loss adjusters and compensates damage.

The Consorcio’s tariff for covering “extraordinary risk” is a rate applied to the insured sums:

TYPES OF DAMAGE	TARIFF	DEDUCTIBLES
Dwellings and dwelling communities	0,08‰	Damage to goods: 7% of the compensable damage
Offices	0.12‰	
Commercial centres, stores/warehouses	0.18‰	Loss of profits: deductible based on the policy
Industrial risks	0.21‰	
Automobiles	Fixed amount depending on the type of vehicle (for cars €2.10/vehicule)	No deductible
Civil works	Motorways, roads, railways, conduits: 0.28‰ Marina ports: 1.63‰	
Injury		No deductible
References: www.consorsegueros.es		

Romania

In case of earthquake, flood and landslide events, compensations are done through the PAID scheme and based on the Type A (insured sum of €20.000) or Type B houses (insured sum of €10.000). 1,678,816 PAD policies are currently issued representing 18.8% coverage ratio at national level. Wind storm and hail are covered by facultative policies, if the citizens are insured for these perils citizens will receive a compensation based on the subscribed policy.

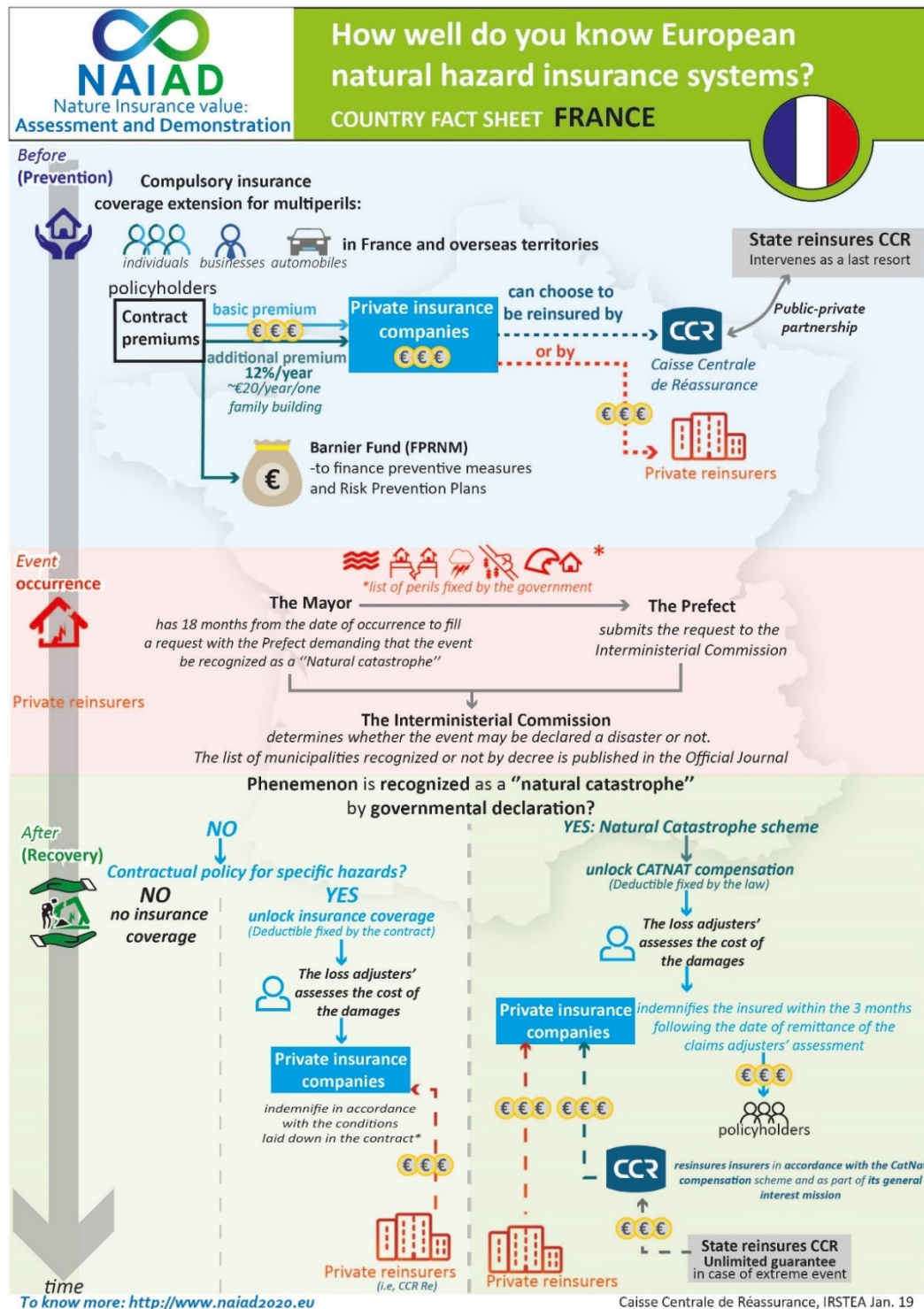


Figure 9: Country fact sheet for France

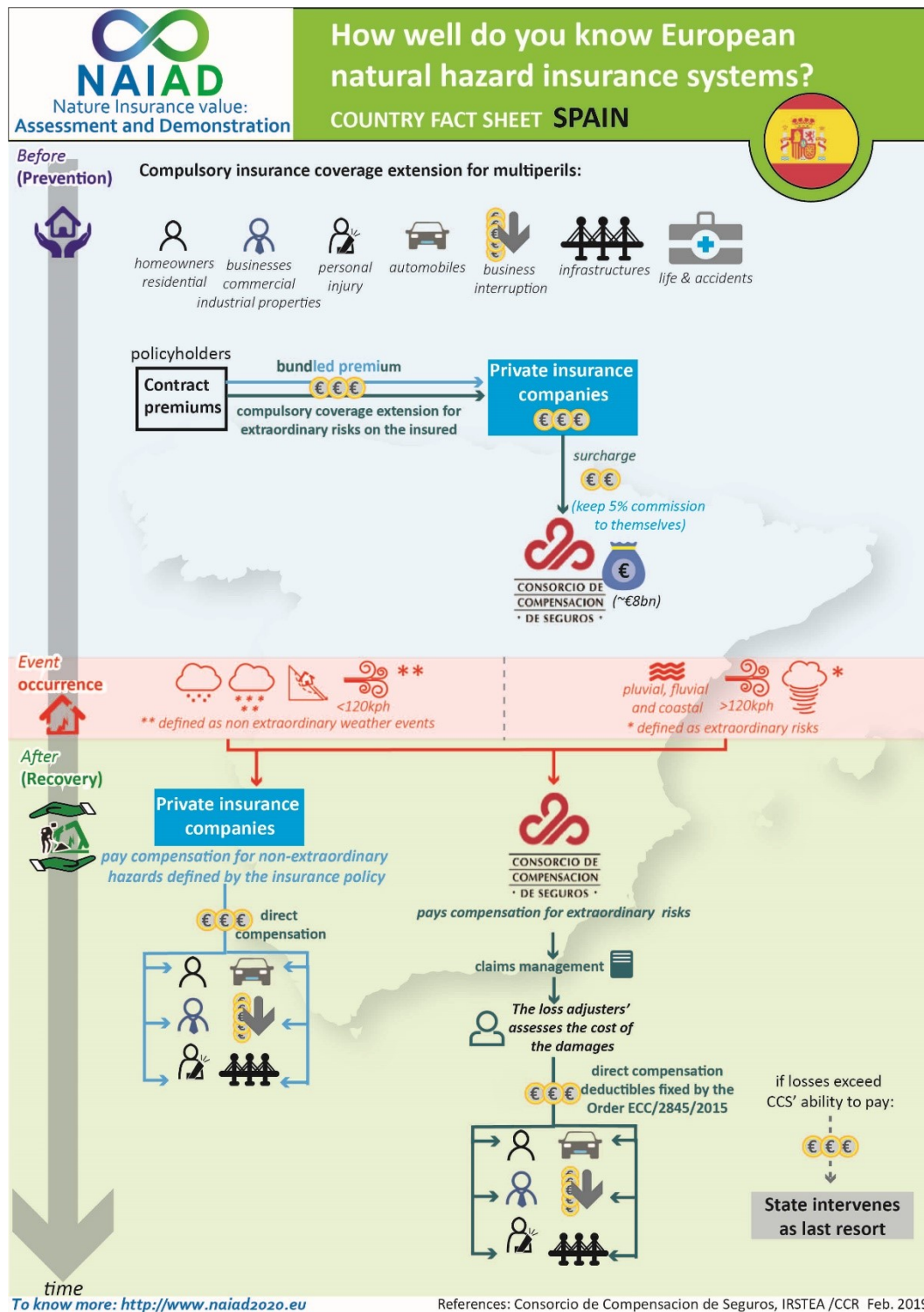


Figure 10: Country fact sheet for Spain

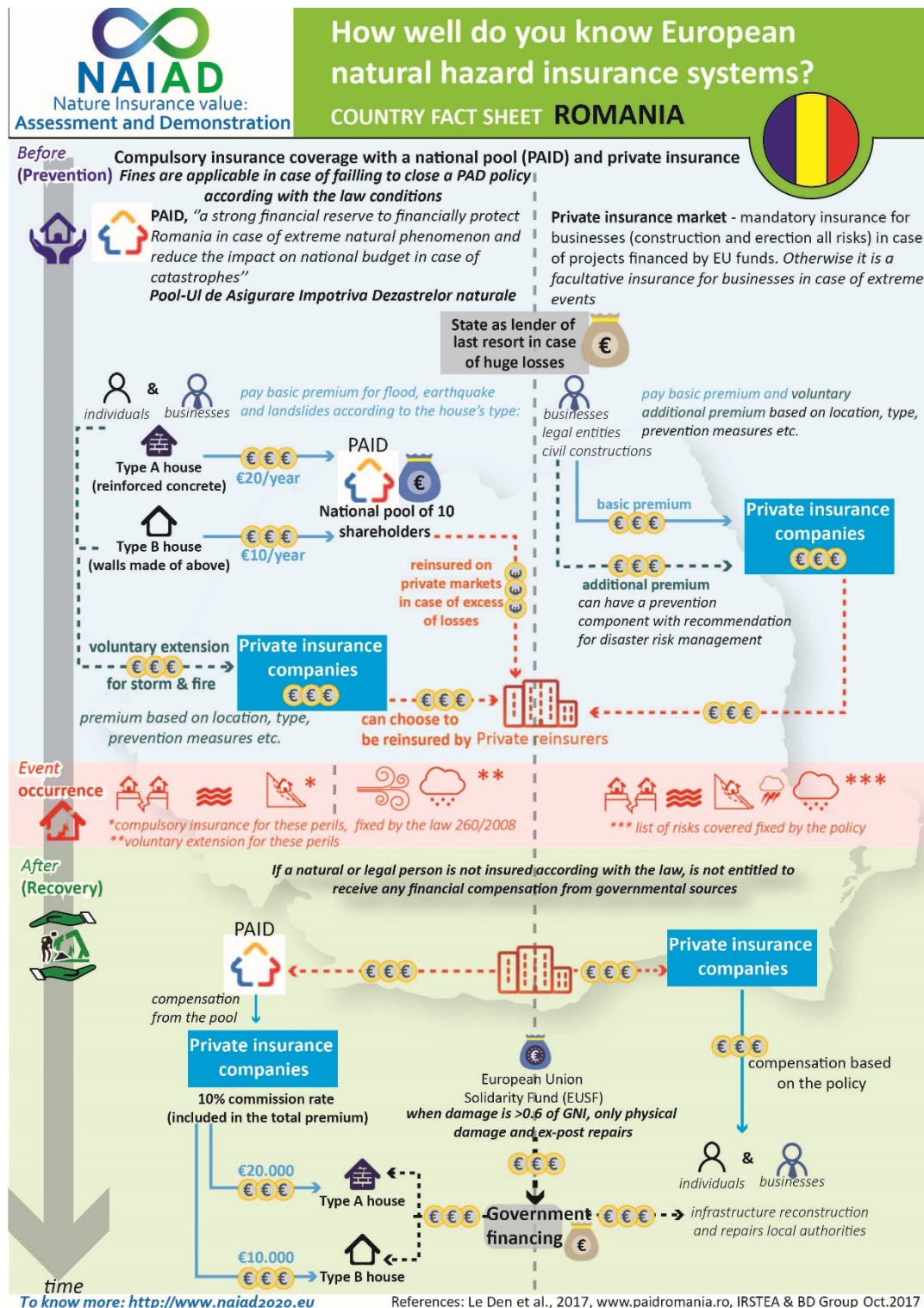


Figure 11: Country fact sheet for Romania



5.3 Insurers' views on disaster risk reduction

"The availability (or lack) of preventive strategies, such as disaster risk reduction (DRR) strategies, preparedness plans or National Adaptation Plans (NAPs), does not directly influence climate and disaster risk or residual risk today, but rather reflects a country's strategic will to manage potential risk in the long term" (Hagenlocher et al. 2017).

"The insurance industry is seen as a highly credible voice on the issue of climate change [...] insurance companies are able to respond faster and more efficiently to climate-related disasters than governments" (Group and Sustainable Insurance Initiative 2015).

From 1980 to 2016, €450 billion of economic losses were reported for the 33 European Environment Agency's member countries, as a result of natural disasters (Agency 2017). From the Swiss Re and Munich Re databases, in 2017, \$306 billion to \$330 billion global economic losses were reported from natural catastrophes, of which only 44% to 41% of these losses were insured, i.e., \$106 billion to \$135 billion, respectively (Swiss Re 2017).

The literature reviewed highlighted the increasing global insured/economic losses from natural catastrophes and the growing interest among insurers on the impacts of (natural) disaster risk reduction to reduce socio-economic impacts to our societies (see Figure 12 for a selection of the core references).

The United-Kingdom Prudential Regulation Authority (PRA) published the first climate change report written by an insurance regulator, on the impact of climate change on the insurance sector in 2014 (Surminski and Kool 2016). (Stern 2006) also indicated that climate change will affect global financial markets through more volatile costs of insurance and the welfare effects of negative shocks. In 2014, the insurance industry itself rated climate change as a generator of physical, transition and liability risks²⁹ (Tomas 2014). The industry is driving itself towards this vision of being the main partner to face climate change, *"the insurance industry must demand that political decisions are taken on climate protection immediately"* said M. Berz, Munich Re's Climate Scientist (Peara and Mills 1999).

²⁹ Physical risks refer to the increase of uncertainties, creation of future risks which will be difficult to model. Transition risks relate to move from carbon economy to lower-carbon economy. Liability risks encompass the impact of natural disasters which may become uninsurable because of the lack of supply (availability of cover) or demand (affordability of premiums).

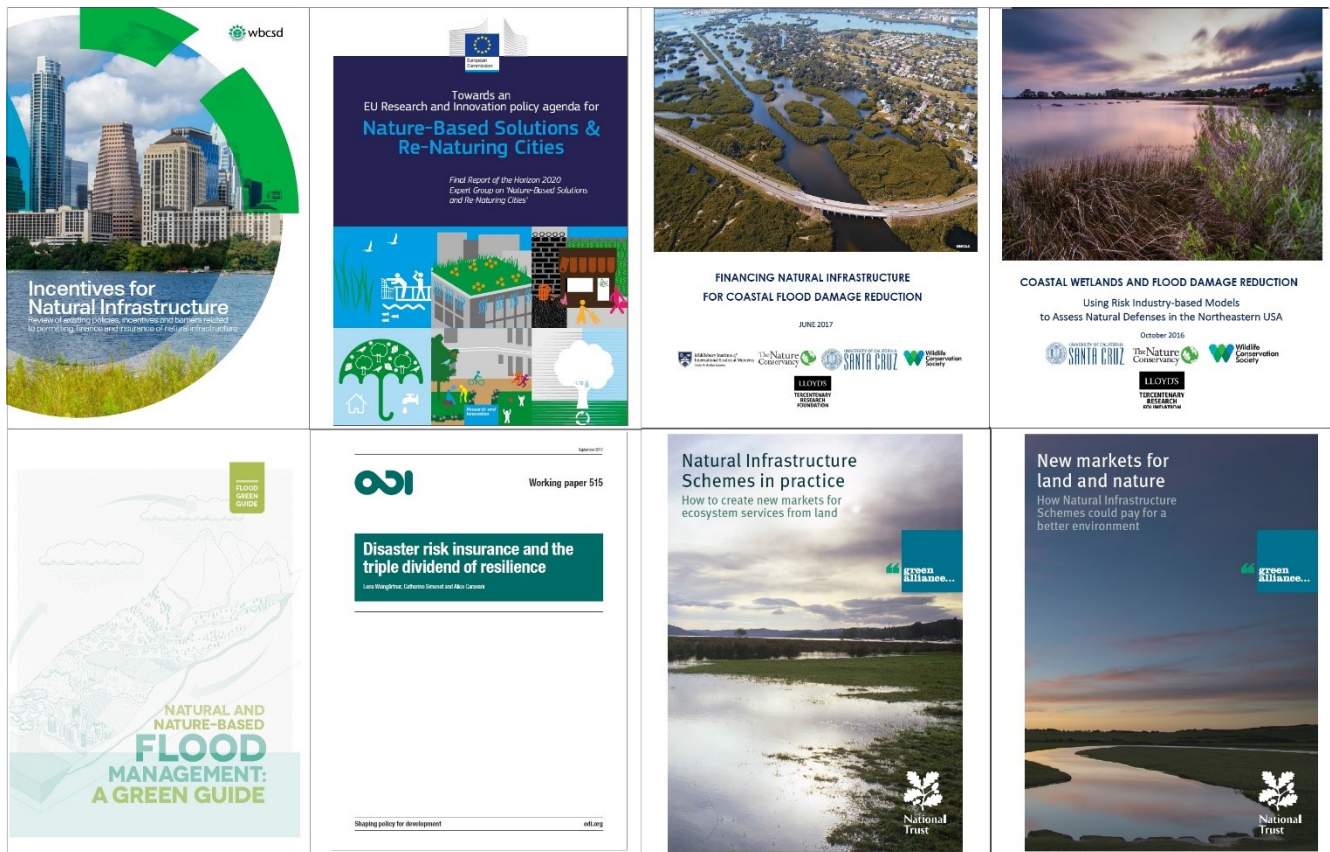


Figure 12: Selection of the core references related to climate change, disaster risk reduction, ecosystem services/NBS) and the insurance industry (References: European Commission 2015, Francis et al. 2016, Narayan et al. 2016, World Wide Fund and US AID 2016, Tipper and Francis 2017, WBCSD 2017, Weingärtner et al. 2017, Colgan et al. 2017)

The insurance industry sees climate change both, as a threat and an opportunity. Through premiums underwriting, insurers provide signals on the increase of natural disasters. Climate change affects the premium calculation, due to more frequent³⁰, more costly and more

³⁰ According to recent reports, some extreme events of today, which have a 20-times return period, may have a 2-times return period in 2020 and a 100-times return period of now, will have a 15-times return period in 2020 (Movie, "Sustainable finance, climate change and insurance" <https://webcast.ec.europa.eu/sustainable-finance-climate-change-insurance#>, website visited 20/11/2017). Thus, actuarial science is an added value to the study of climate change impacts. Their models are based on various potential scenarios and propose risk mitigation strategies completely tailored to the insurance industry (Peara and Mills 1999). Catastrophe models combine tools of numerous professions (climatology, mathematics, finances, insurance), more data/tool exchanges participate to better underwrite natural disaster and to correctly price risks. These synergies have reinvented the actuarial science and underwriting processes which have to take into account climate change scenarios and uncertainties.



unpredictable risks to be insured (Kirbyshire et al. 2017). Thus, insurers are challenged to offer both affordable coverage for properties in high-risk areas, and to be able to calculate their risks to be solvent in case of disaster (Dr. Hlatky n.d., IPCC 2014a, Sousounis and Little Christopher M. 2017). Insurers can lead to the development of new business models to adapt to climate change and to mitigate natural disasters (Flotow and Dr Lutz Cleemann 2009). Nevertheless, some authors state that the current insurance business models are not appropriate to face increasing natural disasters, “[...] *traditional insurance may not be the appropriate tool for longer term foreseeable risks [...]*” (Warner and C. Herweijer. 2009 p. 6), “[...] *most insurance schemes cannot prevent or reduce the likelihood of direct damage and fatalities from extreme weather events [...]*” (Kirbyshire et al. 2017 p. 16).

Climate change adaptation, disaster risk reduction and insurance are dependent on each other: insurers can play a role in adaptation/reduction, while adaptation/reduction ensures viability. Thus, as shown in these two quotations, it is possible to better understand the need of new measures to mainstream investments in risk reduction. As a result of this dependency, the Principles for Sustainable Insurance³¹ serves as global framework for “*insurance industry commitments to build climate and disaster resilience and promote sustainable development*”³². Hitherto, European insurance companies and institutions are less involved than companies/institutions from other regions of the world (Figure 13).

³¹ Launched in 2002, the Principle for Sustainable Insurance highlight linkages between insurers and the United-Nations' Sustainable Development Goals. Insurance companies or other institutions, under their voluntary commitments have to follow four disclosure (UNEP Finance Initiative 2015) (www.uneepfi.org/psi/signatory-companies/ - www.uneepfi.org/psi/signatory-companies/) - the four disclosures are (1) Integrate environmental, social and governance into their insurance business; (2) Work together with clients, business partners to raise awareness; (3) Work with governments key stakeholders; (4) Respect transparency requirements.

³² www.uneepfi.org/psi/

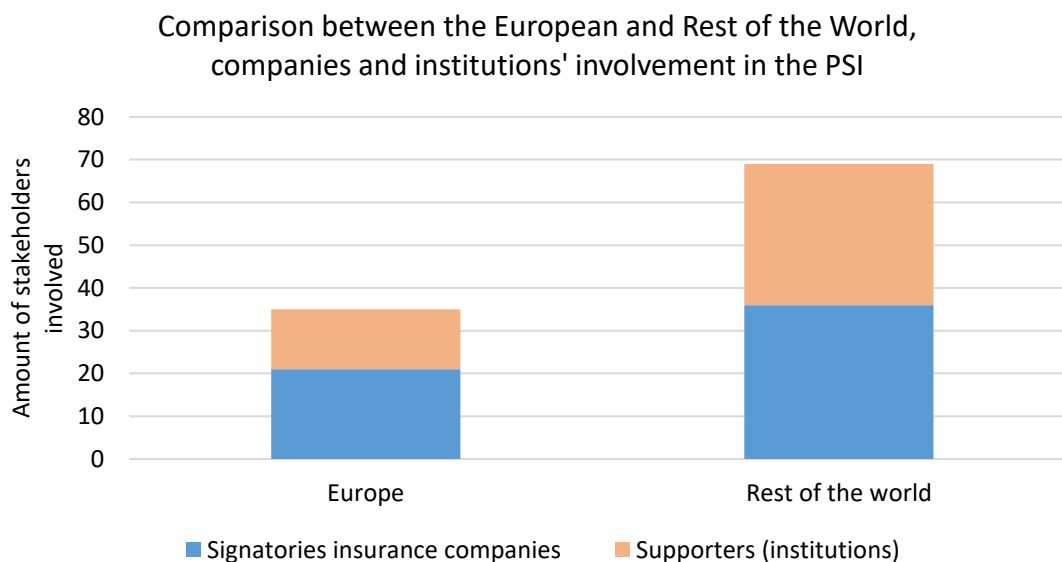


Figure 13 : Comparison between the European and the Rest of the World, companies and institutions' involvement in the PSI (Reference: www.unepfi.org/psi, 2017)

In Europe, the United-Kingdom (8), Netherlands (7), and France (3) are the top three countries with the greatest engagement of companies/institutions in the PSI (Figure 14).

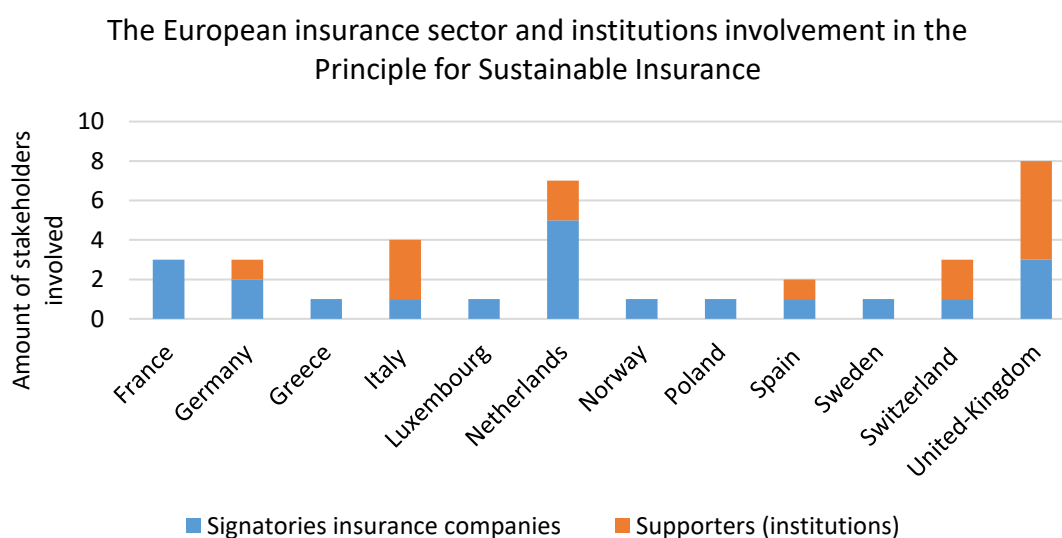


Figure 14: The European insurance sector and institutions involvement in the UNEP Principles for Sustainable Insurance (Reference: www.unepfi.org/psi, 2017).



Being “socially-responsible” to improve societies’ resilience against climate change is the new insurers’ leitmotiv: to decrease the protection gap and to reduce negative impacts of natural disasters. (Surminski et al. 2015) is one of the first authors to think how to link flood insurance and DRR in the EU. The authors explain that efforts to reform flood compensation mechanisms in EU were exclusively based on dealing with financial losses and not with disaster risk reduction. New approaches to link DRR and insurance are needed and under development (Warner and C. Herweijer. 2009).

A number of additional authors agree that the insurance industry has multiple roles and is constantly developing new roles (International Finance Corporation 2016, Kirbyshire et al. 2017, Risk Management Solutions 2017). Those new (re)insurers’ roles can help countries to face disaster losses using: (re)insurance risk assessment expertise; innovative insurance products; and innovations to guide DRR decision making process. As far as scientists and governments are concerned³³, it is noted that insurers could be involved in the improvement of land-use planning and influencing behavioural change for risk awareness. Effective insurance mechanisms and disaster preparedness (protective measures) are more cost-effective than governmental/insurance post-disaster aids (Bacani et al. 2015, Michell 2016 pp. 26–30)³⁴. Emerging markets and a growing demand for green-innovative insurance products, are some of the disaster risk reduction opportunities for the insurance sector.

5.4 Challenges to insurance caused by disaster risk reduction

An increasing number of natural disasters, and the associated increased economic costs of natural disasters, plus greater uncertainties due to climate change, are all challenges for insurers to reduce their exposure to risks. It leads insurers to raise premiums, reduce their risk portfolios and reinsure themselves. Since only 40% of the global damages are insured, this shows the current protection gap worldwide. In 2016, the average insurance penetration in Europe was 35%³⁵ (Le Den and Kuik 2017).

Nonetheless, this could be harnessed by the insurance industry as a business opportunity. The insurance industry interest in resilient risk management strategies is increasing. The reviewed literature highlights that insurers are moving from ex-post recovery to ex-ante measures: *“re/insurance can play a fundamental role in reducing the economic impacts of disasters, the only sustainable way to reduce disaster impacts over time is through investments in risk reduction and building resilience against disaster risks”* (OECD 2017 p. 3).

³³ Such as the sustainability risk management undertake by Swiss Re, sharing data and information (Finance Norway)

³⁴ Financing climate (Axa, Climate Finance Commitments to triple its green investment with a target of €3 billion by 2020).

³⁵ The insurance penetration is expressed by written premiums as a percentage of GDP. Lithuania, Switzerland and Finland are the countries with the highest penetration rate in Europe.



The (re)insurance industry faces numerous challenges caused by disaster risk reduction.

- (1) One challenge for insurers is to move towards nature-based solutions, e.g., such as wetlands, floodplains and coral reefs. These solutions can provide multiple benefits notably for risk reduction (floods, storms, hurricanes). To better understand and/or to implement nature-based approaches in flood reduction, the insurance sector started to fund research on these topics (Dow et al. 2013, Beck et al. 2016, Maynard 2017, Cohn 2017, Colgan et al. 2017). This way insurers improve their knowledge through partnerships with scientists. (Cohn 2017) has demonstrated that *“investment to conserve natural habitats also makes sense for insurers, a report written for Lloyd’s revealed, that it is around 30 times cheaper than building seawalls and “compared to expensive infrastructure, keeping ecosystems healthy prevents climate disasters, saves money and improves resiliency”³⁶”*. Another example is the surprising synergy of companies (Dow Chemical, Shell, Unilever, Swiss Re and The Nature Conservancy) which has highlighted that benefits of green and hybrid, i.e., green & grey, defences against water-related hazards may be re-evaluated by insurance models (Dow et al. 2013). Modelling future disasters and assessing the potential or real reduction benefits of green infrastructures in case of natural disasters is part of this challenge. (Beck et al. 2016) explains the importance of using industry-based models to compare natural hazards damages versus the costs/benefits of NBS. Those tools can be used to quantify both economic benefits of NBS/ecosystem services for property damage reduction and their other benefits (Colgan et al. 2017). Nevertheless, it is not yet a common practice.
- (2) Improving knowledge on NBS e.g. *modelling* reduction potential, is not the only challenge faced by insurers. Determining the insurance *value* of ecosystems is another challenge, through improving the accuracy and precision of their models to take into account the role of ecosystem and to give them an insurance value. One of the last scientific articles (Narayan et al. 2016), defines IVE as *“greatest value where they are the most extensive or in front of the greatest assets”* and as *“the economic value of a coastal defence solution will depend on the value and distribution of at-risk assets that benefit from reduced flooding (avoided damages and the replacement costs of grey infrastructure)”* (Colgan et al. 2017). Several references demonstrate the insurance value and benefits of ecosystems in risk reduction and decrease vulnerability and thus, insured damages/costs (Beck et al. 2016, Narayan et al. 2016, 2017, Colgan et al. 2017). To value ecosystems, economists have to know the risk, to

³⁶ “Protecting nature is Canada best defence against flooding”, www.huffingtonpost.ca/david-suzuki/protecting-nature-is-canada-best-defence-against-flooding_a_23005076/



have information on the state of ecosystems, information on interaction and coupling between ecosystems and hazards, on the current natural infrastructure financing and financing capabilities (Colgan et al. 2017). The challenge is to develop a calculation model to determine the economic and insurance value of ecosystems as accurately as possible (Baumgärtner and Strunz 2014). (Silvis and Heide 2013) have summarized several methods to determine the value of ecosystem services, such as the willingness to pay, opportunity costs, producer surplus³⁷ and how to help the decision-making processes³⁸. The same authors explain the difficulty to quantify ecosystem services in purely monetary terms, to make the difference between the use and non-use values and to under or overestimate this value. Overcoming gaps (i.e., knowledge, organisational, definitions etc.) between economists and ecologists is needed to avoid irreversible damage on nature. A wide consensus among scientists, economists, decision-makers and insurers is needed to mainstream the insurance value of ecosystem into regulatory policies. (Brown et al. 2014) add the importance of robust ecosystem services indicators (assessment, mapping, (non)economic valuation, natural capital, legal instruments, spatial planning) as tools to build new business models.

- (3) Disaster risk reduction-related challenges are sensitive because disaster risk management systems are still based on ex-post measures. (UNEP Finance Initiative 2015, WBCSD 2017) agree that insurance companies are challenged to focus their attention on natural infrastructures as a good way to diversify their risk management strategy, to improve their capacity to adapt to climate change and to reduce their capital costs. These studies demonstrate that NBS and eco-DRR are markedly more sustainable and profitable for both the insurance sector and ecosystem conservation. Previous studies also demonstrate that preventive measures (structural and non-structural^{39, 40}), before any disaster strikes, are more cost-effective than post disaster

³⁷ The willingness to pay is the amount individuals are prepared to pay for goods and services. It is the most used method. Opportunity costs are the value of something in its next best alternative use. Producer surplus is the profit that a producer makes for selling a product.

³⁸ Methods to help decision-making process are: (1) Cost-benefits analysis, conventional economic approach to quantifying and evaluating projects; (2) Cost-effectiveness analysis, calculation of cost per unit of benefit (3) Cost-assessment, assessment of the cost of regulating business; (4) Risk-analysis, quantitative assessment of the magnitudes of the risk affected by the policy and their associated consequences; (5°) Multi-criteria analysis, the best alternative that satisfies a pre-determine set of objectives, most preferred option (mixture of monetary and non-monetary objectives).

³⁹ Structural measures such as natural infrastructures and non-structural measures such as risk maps or individuals risk awareness and knowledge.

⁴⁰ According to Sendai (2015) "Structural measures are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. Non-structural measures are measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education"



response and recovery processes. This has challenged the industry to design affordable and viable insurance schemes which provide incentives for DRR measures (Susanne and Patt Anthony 2017).

- (4) Investments in nature-based solutions are *“critical for reducing and preventing economic losses associated with disaster”* (Golnaraghi and A. M. Gordon 2017 p. 4). The insurance industry is starting to understand the co-benefits and co-costs of risk sensitive investments even in the absence of disasters (Kirbyshire et al. 2017). Indeed, disaster risk management combines long-term risk reduction, resilience response and improved recovery processes (Network et al. 2017). Increasing the amount of insured damages encourages insurers to innovate even more to cover uninsurable risks and to update their business models. The challenge for the industry is to work with governments and scientists, with the aim to design new finance/business mechanisms to support greater investment in NBS/ecosystem-based disaster risk reduction (eco-DRR) (Oppla 2017). Less damages mean less money spent by the insurance industry. The Triple Dividend of Resilience is one theory trying to demonstrate to the insurance industry the multiple co(st)-benefits of disaster risk management whether or not disaster event occurs (Rentschler and Tanner 2015, Tanner et al. 2015, Kirbyshire et al. 2017). (Tanner et al. 2015) state that the Triple Dividend of Resilience is *“a new business case for disaster risk management”*:
1. The first dividend focuses on the fact that disaster-resilient financial investments will reduce the probability of a disaster happening, and that way protect lives and secure development progress.
 2. The second dividend highlights the importance of both preventing disaster losses and maintaining affordable insurance.
 3. The third dividend demonstrates the variety of co-benefits and cost-savings, the spill over effects of DRM investments.
- (5) The (re)Insurance industry is challenged to become a key driver to link resilience to disaster, climate change adaptation, investments, preservation of the environment, as means towards co-beneficial, ex-ante prevention measures, *“investments in habitat conservation that reduce [coastal] risk could reduce premiums on insurance and insurance linked securities⁴¹ (such as resilience bonds). In this way, habitat restoration could pay for itself in savings. After a disaster strikes, private insurance*

⁴¹ Insurance-linked securities (ILS): *“a proportion of funds are held in reserve and allocated according through the ILS features and a proportion is transferred away through insurance contract to cover the risks of major events”*. This definition come from (Network et al. 2017), especially for drought hazard, but as say in the report *“this could be applicable for other natural hazards”*.



and public recovery funds can support wetland conservation, with the benefits of further reducing insurance premiums and building coastal resilience against future disasters. The risk and insurance industry can play a critical role in wetland restoration for disaster prevention and recovery” (Stephens 2017 and Network et al. 2017).

5.5 Insurance addressing disaster risk reduction

In response to these challenges, the insurance industry has ways to include NBS in their risk assessment and risk financing expertise for eco-disaster risk reduction⁴² and environmental concerns (Dow et al. 2013). The insurance industry’s interest in scientific research on the insurance value of ecosystems is rising. A few examples:

- (Barbier 2013 p. 10) estimated that *“an equivalent marginal increase in wetland continuity over approximately 6km would lower residential property flood damages by \$592.000 to \$792.100”*.
- A study led by Swiss Re and ICUN has demonstrated *“that every dollar invested in the Folkestone Marine Part on the west coast of Barbados (USA), for instance, could reduce 20 dollars of hurricane loss”*. (Murti and Buyck 2014 p. 15)
- More recently, a study shows that wetlands avoided \$625 million in direct flood damages during Hurricane Sandy (Narayan et al. 2017).

Only a few studies have focused on forest areas or riparian forests (Renaud et al. 2013 p. 36, Sudmeier-Rieux et al. 2013) and the valuation of their ecosystem services protection. Nonetheless, (Colgan et al. 2017 p. 35) declare that *“public and private insurance systems that are insufficiently focused on reducing future risks [...] funding organizations that are unaware of potential natural infrastructure opportunities and/or lack the flexibility to support the kind of creative financing approaches needed”*.

Eco-disaster risk reduction requires specific approaches which focus on advocacy (economic importance of ecosystem services and sustainable development), decision-making (to assist governments), damage assessment (assessing damage inflicted on an ecosystem), and sustainable financing (valuation of ecosystem services that can be used to set taxes or additional charges) (Silvis and Heide 2013), and (Colgan et al. 2017 p. 7) argue that financing natural

⁴² The IUCN define Ecosystem-based disaster risk reduction (Eco-DRR) *“as the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to achieve sustainable and resilient development. Well-managed ecosystems, such as wetlands, forests and coastal systems, act as natural infrastructure, reducing physical exposure to many hazards and increasing socio-economic resilience of people and communities by sustaining local livelihoods and providing essential natural resources such as food, water and building materials. Ecosystem management not only offers an opportunity to strengthen natural infrastructure and human resilience against hazard impacts, but also generates a range of other social, economic and environmental benefits for multiple stakeholders, which in turn feed back into reduced risk”*. <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-thematic-groups/eco-disaster-risk-reduction>



infrastructures is based on both public and private investments and at both individual and community actions. This raises two important questions: 1) “Who pays?, 2) Who benefits?”.

Nonetheless, there is still a significant gap between money spent on disaster response and disaster risk ex-ante prevention “*the typical range of measures have a cost-benefit ratio in excess of £5 for every £1 invested in terms of reduced damages*” (Bonfield 2016 p. 11) or “*\$7 spent on relief vs. \$1 spent on risk reduction*” (Rentschler and Tanner 2015 p. 9). As the insurance sector is the largest institutional investor in Europe a number of authors including Insurance Europe as the industry representative organization agreed the importance of the topic “*sustainable finance, climate change, climate risks and insurance*”⁴³ (Pearce 2000, Sudmeier-Rieux 2013, Insurance Europe 2016). The Paris Agreement (2015) has confirmed this direction in the global commitment to orientate financial markets in this way as can be seen in article 2, §C “*making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development*” and article 9 §3 “*mobilizing climate finance*” (United Nations Framework Convention On Climate Change 2015).

The industry is traditionally involved in short term investments, but climate change and unpredictable extreme weather events have meant a switch towards longer term investments. In this way, the EU has defined a 20% target on the integration of climate objectives into budget allocation decisions by 2050⁴⁴ (IEEP et al. 2017). Insurers could invest in green infrastructures (restoration or maintenance). The insurance industry has numerous ways to invest for rebalancing portfolios into long-term investment strategies. (Lovink et al. 2004) have proposed the creation of an eco-insurance system, based on eco-insurance premiums collected to make long-term investments into ecosystems preservation and prevention insurance policies to support ecosystem to prevent losses of ecological goods and services (i.e., “NatureSave” of the Lloyd of London or the QBE Premium 4 Good Programme⁴⁵). Using insurance/global markets to invest in NBS for reducing risk is an emergent risk transfer scheme.

Hurricane Andrew triggered the launch of the first non-traditional reinsurance structures: catastrophe and green bonds⁴⁶. After signature of the Paris Agreement, green bond investments

⁴³ Movie, EU, “Sustainable finance, climate change and insurance”, <https://webcast.ec.europa.eu/sustainable-finance-climate-change-insurance#> website visited the 20/11/2017

⁴⁴ Such as e.g., promotion of insurance and other financial products or subsidies, tax incentives, guarantees etc. At the European level, the European Investment Bank (EIB) administers the Natural Capital Financing Facility (NCFF) which finances research projects that use NBS to adapt climate change.

⁴⁵ <https://www.qbe.com.au/campaigns/premiums4good> , visited March 7th 2018

⁴⁶ The creation of the Green Bond Principles (GBP) in 2007, by a bank consortium and managed by the International Capital Market Association (ICMA), has established standards and guidelines for ecological investments. The Climate Bond Initiative (2007) is based on the same standard models (Climate Bond Certified).



have increased significantly. The green bond issuances (Boulle et al. 2016) and in climate insurance (Surminski et al. 2016) have largely increased to beat all previous records in both 2015/2016. The catastrophe bond market, so-called “cat bond⁴⁷” created in 1994, is a financial instrument dedicated to covering against specific defined risks and issued by insurers, reinsurers and bankers. These are linked to Insurance-linked securities (ILS), which are financial instruments sold to investors whose value is affected by an insured loss event (Edesess 2014). Cat bonds are very useful for disaster risk reduction because, “*cat bonds buyers have an incentive to reduce risk in order to reduce the price paid for the bonds*” (Colgan et al. 2017 p. 18). (Colgan et al. 2017) states that money saved (avoided damages) is capitalized to finance NBS projects through bond markets. NBS could enter in the market by meeting: a revenue source to repay the bond buyers and a set of performance standards to demonstrate (flood) risk reduction goals (Colgan et al. 2017). Thus, according to (Gorvett 2014) market-based approaches are better to lead the insurance market to integrate NBS. One example of an insurance company’s involvement in the use of NBS is Santam⁴⁸, the largest agricultural insurer in South-Africa, which is engaged in providing financial support to Living Lands⁴⁹ to plant trees. The objective is to reduce land degradation (restore landscapes) and restore the water catchment system (to reduce drought risks). By reducing drought risk Santam will spend less money in agricultural claims related to drought.

One other pre-disaster strategy, for the insurance industry to address disaster risk reduction challenges, is to incentivize protective measures. Insurers’ innovation can therefore be profitable for insurers and the insured (Mills 2013, Sustainability Leadership (CISL) 2016). Insurance incentives for policyholders are currently at an early stage in Europe (Mills 2013).

Institutional investors orientated market demand for responsible economy and environmental benefits of financed projects. Climate Markets and Investment Association (CMIA) support the private sector to transform policies into well-designed strategy investments. With this multiplication of issuers, from public/private sectors, the ICMA had created complex guidelines to well-defined, clarified approaches for issuers and to monitor green bonds. The latter is planned to fund economically viable and environmentally friendly projects. To ensure the well-functioning of green bond markets, the ICMA has developed, the Green Bond Principles, which are credible and unassailable guidelines based on 4 pillars to avoid accusation of greenwashing investments (International Capital Market Association 2016 (OECD 2015b)). Private investors are newly involved in those bonds markets, more and more industrials or local authorities want to finance green projects and to reduce carbon path of their financial portfolios. ICMA helped by independent societies certified (e.g. HEY, CICERO, Sustainalytics), labelled the bonds, “green bonds”: consultant review, verification, certification and rating.

⁴⁷ According to (Edesess 2014), Cat Bonds are dedicated especially for four basic trigger types: (1) Indemnity trigger (covers actual excess claims aid); (2) Industry loss trigger (coverage based on whole industry losses in the extreme event); (3) Parametric trigger (coverage based on exceedance of specified natural parameters) and (4) Modelled trigger (coverage based on claims estimated by a computer model).

How does the Cat bond issuance work? Whether a disaster strikes or not? In case of no disaster occur during the years defined in the contract: investors who have purchased bond are reimburse of the initial bet plus advantageous rates. If a disaster strikes during the years defined in the contract: investors who have issued bonds “really lost” their money, the society who have issued the bond can keep the investors’ moneys to repair damages. It is a real advantage because the society already has all the money needed (it is not a loan).

⁴⁸ Online article, BARBEE Jeff, « Insurance firm turns to planting trees in South Africa to combat drought risk », The Guardian, 23/12/2015, <http://www.theguardian.com/environment/2015/dec/23/insurance-company-turns-planting-trees-south-africa-combat-drought-risk>

⁴⁹ Living Lands is an international not-for-profit organization, <http://www.livinglands.co.za>



According to (Kirbyshire et al. 2017), involvement of the insurance sector in risk reduction will generate a more viable, affordable, accessible and scalable insurance. (Warner and C. Herweijer. 2009, Kirbyshire et al. 2017) both suggest that risk reduction measures should be a pre-condition to purchase insurance coverage. The insurance sector has to demonstrate the cost-benefits of these measures to the policyholders even in the absence of disaster. It is an opportunity for the industry to enhance behavioural change in risk awareness through incentives to implement resilient measures (Mysiak and Surminski 2013, Hudson 2015, Michell 2016, Thistlethwaite and Minano 2016, Kirbyshire et al. 2017). Policyholders' investments in loss reduction have to be incentivized by insurance companies through the creation of premium discounts (European Commission 2013, British Insurers 2016).

(Cohn 2017) argues that ecosystems' role in risk reduction should be considered by insurers when they are setting premiums. The money saved through the avoided damages could be used by insurance company to manage, restore, improve ecosystem services, "*it is a winning solution*" (Paudel 2012). (Mills 2013) exemplifies this with the German case, where citizens are encouraged to pursue mitigation measures mainly because houses located in high-risk areas pay higher premiums. Unlike a flat-rate premium the use of "*standardized premiums have the disadvantage of not costing risk adequately and transparently*" (Honegger et al. 2016). Risk-based premiums⁵⁰ are widely used as the example to stimulate policyholders' investments in disaster risk reduction measures, and to decrease moral hazard (Mills 2013). (Botzen and Bergh 2008) highlight that risk-based premiums are better to tackle climate change and to mitigate damages. Nevertheless, according to the GDV (German Insurance Association 2013) considering these measures in premium calculation is complex. It is complex to set individual premium for each house, this requires strong and effective underwriting standards for specific types of hazards (not all measures are effective for all types of flood for instance), to assess and compare their performance.

According to (Surminski et al. 2015), risk-based pricing is necessary but not sufficient to prevent moral hazard and to incentivise DRR. (Schwarze 2012) defends the idea that incentives based on premiums seem more effective than based on deductibles. Deductibles are paid just in case of disaster, on the opposite, premiums are paid monthly or annually, with this system, people are more prone to adopt moral hazard behaviour. Policyholders take the risk to pay higher deductibles rather than undertake risk reduction works. (Mills 2013, IPCC 2014a, 2014b) argue that paying attention to well-designed protective measures is crucial to avoid disincentives, market failure and decreased equity. Thus, with time and after each disaster, betterments are affected, damaged or may be destroyed, insurers will have to re-assess effectiveness. There are no standards so far to estimate the risk of a protected home compared to one that has no protection, or any instruments to monitor protection for people (Surminski

⁵⁰ Risk-based premium reflects the policyholders' risk and the protective measures they have implemented.



et al. 2015). The idea can be to create a “*standard for protection*” that could help insurers to take into account protections in insurance premiums (Environment and Rural Affairs 2011). In the United-States, the National Flood Insurance Program (NFIP) has implemented incentives at the community level and for each policyholder (see Appendix 5). Nevertheless, “*despite arguments for reducing public disaster assistance in favour of risk based insurance programs, no country in Europe can claim full risk based insurance pricing [...] many countries have experienced difficulties in implementing reforms in this direction*” (Susanne and Patt Anthony 2017 p. 2).

Finally, insurance strategies addressing disaster risk reduction through nature-based solutions and climate change adaptation have been interlinked with societies’ resilience efforts (IPCC 2014b). Some pioneering experiences are happening with the insurance industry using its underwriting skills to insure ecosystem services, a natural infrastructure, “*a section of coral reef off Mexico has been given its own insurance policy*”⁵¹. (Bishop et al. 2010) argue that the industry has to monitor and restore ecosystems for preserving their protective role to reduce damages from storms, flooding and droughts. The attribute Table 5 based on (Le Den and Kuik 2017), presents how the insurance policy works. The second document, Figure 15, is an official publication to highlight the importance of ecosystem services in disaster risk reduction.

⁵¹ “A section of coral reef off Mexico has been given its own insurance policy” by Maeve Heslin in Lonely Planet, 23/08/2017, <https://www.lonelyplanet.com/news/2017/03/23/section-coral-reef-off-mexico-given-insurance-policy/>



Table 5 : Attribute table for The Reef and Beach Resilience and Insurance Fund (RRIF) in Puerto Morelos and Cancun (Mexico)

ATTRIBUTE	SECTOR
	Ecosystem services
Name, year of establishment	The Reef and Beach Resilience and Insurance fund (2017)
Hazard(s) covered	Storms; Pollution;
Official trigger: Yes / no; Description?	Yes, in case of major storm
Type of insurance, e.g. bundled, parametric triggers	Parametric triggers insurance
Compulsory vs. voluntary vs. PPP	PPP between Swiss Re, the Government, The Nature Conservancy and the local businesses
Ecosystem insured	Coral reef - Cover 40-mile length of reef (~65km) "Healthy coral reef can reduce 97% of a wave's energy before it hits the shore" The Nature Conservancy.
Damage covered	Damage to buildings and contents + damage to coral reef
Policyholders	Local businesses (hotels) pay the premium because they are protected by that reef
Limit of compensation	Parametric features
Value of coral reef for tourism	~\$36 billion
Value of coral reef in avoided damages	~\$6 billion ⁵²
Individual policy deductibles	?
Risk Reduction	/
Incentives based on: Premiums/Deductibles/Other	
Market penetration rate	?
Premium setting rule, e.g. risk based, flat, fixed percentage of insured value?	Premiums based on the parametric criterion
Reinsurance access: Private /Public	Private reinsurance
Average annual premium	?
Access to public disaster response fund	?
Pay-out speed	10 days in order to repair the reef and beaches as soon as possible If the policy trigger is not damaged, there is no pay-outs
Additional comments	The objective is to support protection and repair of coral reef in case of storm. Thus, it is a support for tourism activities related to the reef. It is a financial resilience against climate change It is insured by Swiss Re AG, "create a fresh source of revenue". "The first in the world to tie environmental benefits and the "ecosystem services" provided by natural environmental features to firm monetary costs and rewards" ⁵³

⁵² "Insuring nature to ensure a resilient future", <https://global.nature.org/content/insuring-nature-to-ensure-a-resilient-future>

⁵³ "Mexico launches pioneering scheme to insure its coral reef" Fiona Harvey, 20/07/2017, <https://www.theguardian.com/environment/2017/jul/20/mexico-launches-pioneering-scheme-to-insure-its-coral-reef>



References: <https://www.lonelyplanet.com/news/2017/03/23/section-coral-reef-off-mexico-given-insurance-policy/>,
<https://global.nature.org/content/insuring-nature-to-ensure-a-resilient-future>,
<https://www.theguardian.com/environment/2017/jul/20/mexico-launches-pioneering-scheme-to-insure-its-coral-reef>

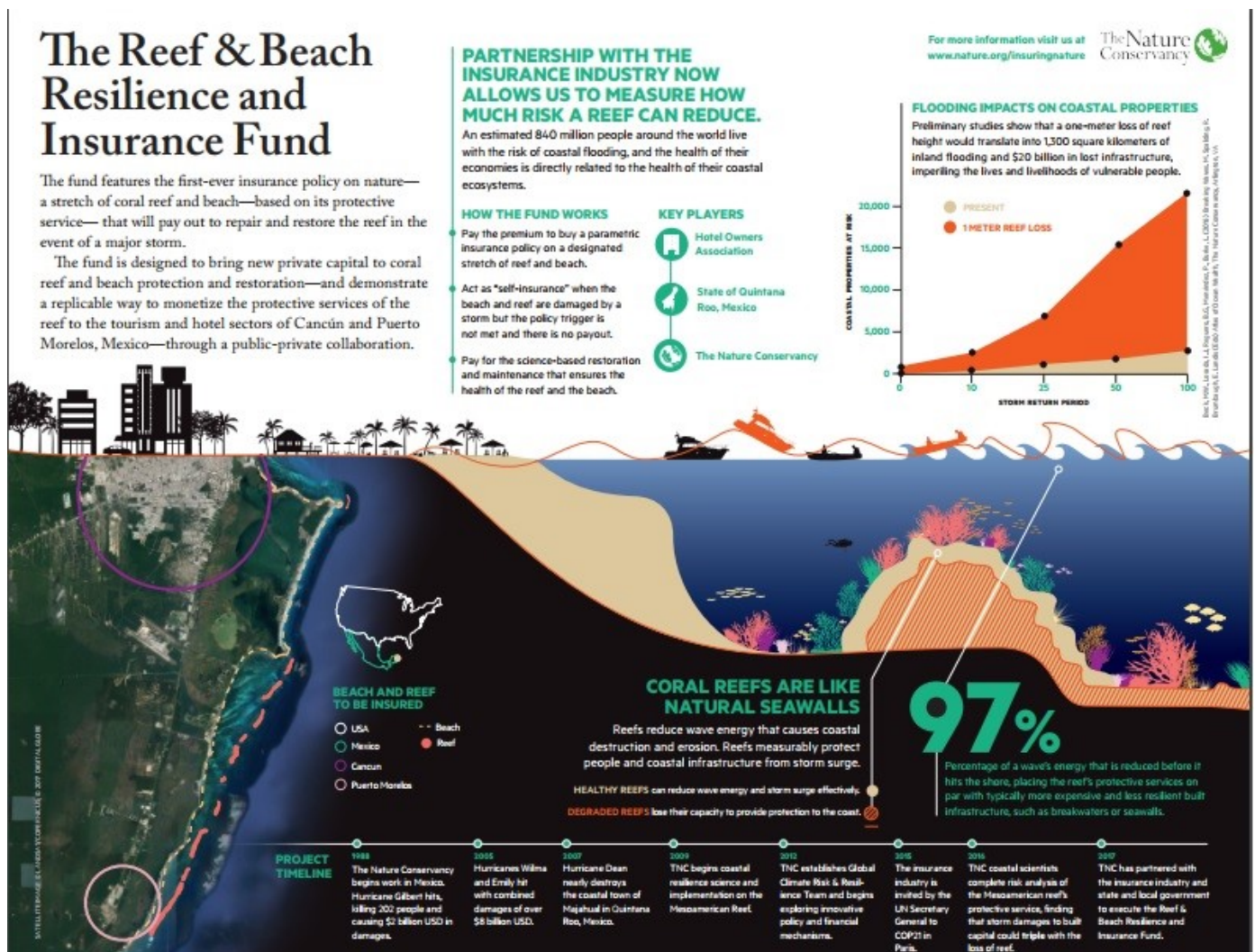


Figure 15: A poster from The Nature Conservancy on the RRIF, 2017⁵⁴

⁵⁴ For more information visit: <https://thought-leadership-production.s3.amazonaws.com/2017/07/14/20/58/36/9cc4164c-751e-4903-abb0-140652dc5316/RBRIF%20Infographic%20FINAL%2007142017.pdf>



Eco-disaster risk reduction (eco-DRR), is characterized however, by complexity and interdependencies that require new scheme tailored to the insurance industry. The insurance industry is not a panacea (Schäfer et al. 2016). Yet the expectation is that the insurance industry focuses its relations with governments to develop resilient building standards, to restore ecosystems to protect cities from natural hazards and to quantify the economic value of NBS in insurance risk models (Maynard 2017). It is a worldwide ongoing process which gathers all stakeholders across different policies and financial instruments. Nevertheless, (Kirbyshire et al. 2017) defend the idea that financial infrastructures, regulatory frameworks and data are inadequate and non-existent to integrate NBS and that only a minority of schemes show any link between risk transfer and risk reduction. However, some authors are devoted to develop a Natural Infrastructure Scheme (NIS) framework and how it could work (Francis et al. 2016, Tipper and Francis 2017). This NIS is defined as *“an area based market in avoided costs, delivering environmental improvements by bringing together groups of land managers to sell ES to groups of beneficiaries and as a flood defence partnerships”* (Francis et al. 2016). It takes place at the catchment scale. The framework is that landowners in catchment area create a contract with the downstream businesses and the public sector, with the objective to increase the ecosystem services provided by their lands in disaster risk reduction. The current declining state of health of ecosystem areas reduces their ability to face climate change and natural hazards. Thus, the sellers are a consortium of landowners who receive money to restore and maintain their lands. The buyers are a consortium of beneficiaries (e.g., insurance company) of flood mitigation and other benefits provided by the ecosystems services (Appendix 6). The insurance industry has a new role in supporting national and local economy to foster sustainable development. This highlights the need to develop new products with the aim of both protecting against natural hazards and ensuring new businesses that offer solutions in terms of mitigation and adaptation (UNEP 2016).



5.6 Recent developments related to disaster risk reduction (DDR), climate change adaptation (CCA) and NBS

 European/Worldwide policies	 Natural infrastructures	 Benefits of resilience	 Financing and incentives
• Sendai Framework, Paris Agreement etc. • First report on impacts of climate change on the insurance industry (PRA UK 2015) • Different Member States insurance mechanisms (typology and differences from one to another at national level) • Reports increasingly linking DRR, NBS, CCA and insurance	• Increasing interest on NBS as solutions for DRR/CCA • New investments in green measures • IVE rising interests. A metaphor of how natural infrastructures protect societies	• Necessary to move from ex-post to ex-ante solutions (Currently more money spent on recovery than for prevention) • Increase insurance industry interest in resilience • Sustainable Nature Assurance Schemes: to consider ecosystem services when valuing risks and consider investments in restoration • New insurance products (parametric insurance)	• Increase of green/cat/resilience bonds • Incentives to move from short to long-term investments • New partnerships
<i>Increase of DRR and CCA targeted policies</i> <i>From fragmented to inter-sectoral policies (integration)</i>	<i>Climate change: both threat and opportunity</i> <i>Increase interest on the role of NBS backed by evidence that takes into account uncertainties</i>	<i>Raising awareness on the potential multiple benefits of ex-ante eco-DRR investments</i>	<i>New ways to finance NBS and emerging standards</i> <i>A trend towards re-awarding protective measures implementation</i>



6. Interview results

The study is based on interviews with the (re)insurance industry and linked stakeholders as summarised in Figure 17 and Figure 18. The analysis was undertaken both using a quantitative analysis and also qualitatively based on a grounded theory approach to analyse interview data from sixty-one interviews in 11 NAIAD countries⁵⁵ as can be seen in Figure 16. The study explores the linkages between (re)insurance companies and disaster risk reduction, climate change adaptation and nature-based solutions focusing on the operationalisation of the insurance value of ecosystems. The interviews highlighted five main areas:

- (1) the insurance industry's vision on climate change;
- (2) the insurance industry's understanding of nature-based solutions and the insurance value of ecosystems;
- (3) (eco)-disaster risk reduction is challenging the insurance industry;
- (4) the role of the insurance industry in supporting (eco)-disaster risk reduction;
- (5) the important role of the European Union.

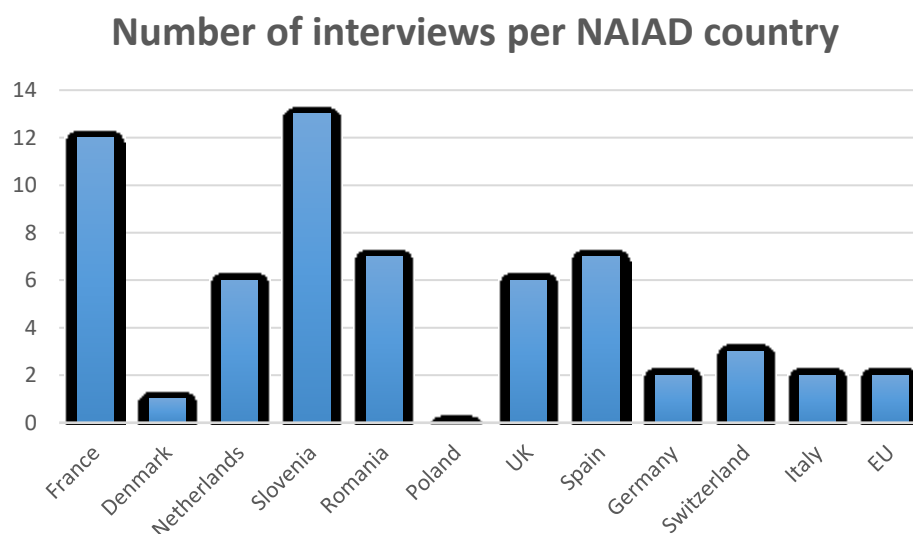


Figure 16: Interviews per NAIAD country

⁵⁵ The semi-structured interviews have been done between July 2017 and December 2017 in the 8 DEMOs countries (France, Denmark, Netherlands, Slovenia, Spain, UK, Romania) Poland DEMO have faced numerous difficulties to take contact with stakeholders, no interviews have been performed. Switzerland was chose as a case study to replace Poland. By 12 different interviewers. A total of 61 interviews were performed for an average duration of 90 minutes; the shorter interview has lasted 30 minutes and the longer 95 minutes.



THE PANEL OF INTERVIEWEES

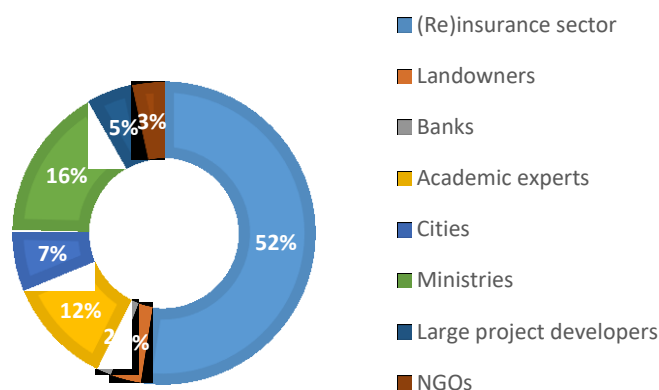


Figure 17: The panel of interviewees

INTERVIEWEES IN RELATION TO THE (RE) INSURANCE SECTOR

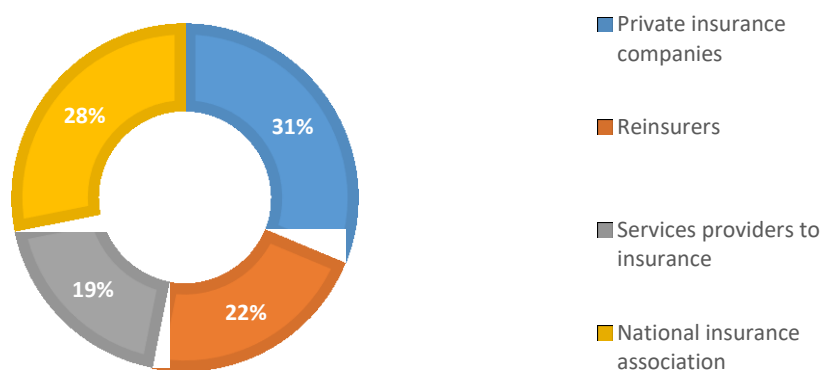


Figure 18: Interviewees in relation to the (re)insurance sector

NOTE: Note that in the reporting of results in compliance with ethical requirements, quotations are anonymous unless we have obtained written consent of the interviewee to be cited. The code Txx is for NAIAD partners use only.



6.1 The insurance industry vision of climate change

Most companies have declared to be aware of the impacts of climate change on natural hazards. Interviewees argued that insured claims are rising and will rise, as well as the premiums. Companies are exploring strategies to decrease risks and claims. Nevertheless, participating companies have also argued that addressing climate change also needs an internal change in mentalities and in raising awareness. From their own data, interviewees told us that it appears there might have been some rise of catastrophic events over the last years, but that it is still too soon to have statistical support of data to state that climate change is the cause of this increase: *“we have probably seen a slight increase in the frequency of major storms (etc). I do not know if this has something to do with climate change or not”* T55.

Almost all participating companies have established scenarios, global reflections and exchanged experience on how climate change impacts the industry and their companies: *“the insurance industry is aware of climate change and undertake lots of efforts to understand how climate change impacts some risks”* T31.

Climate change challenges are integrated in the insurance industry scenarios although with different visions. Climate change is being considered by (re)insurance companies in three ways, (1) as a challenge for insurers’ timescale scenarios; (2) as a challenge for insurers’ models; (3) as a range of new services to be integrated into core business.

(1) Interviewees agree that climate change impacts globally but that it is difficult for the companies to assess and measure it at a smaller spatial scale.

Interviewees also indicated that insurers and scientists have different timescales for climate change impact assessment. Climate change involves long-term vision, insurers have declared to be challenged since they are currently working on the short term, to assess and have a clear vision of future climate risks and climate change uncertainties: *“In the short-term we do not take into account the impacts of the climate change. At middle/long term, it is an ongoing process to integrate these impacts, but the lack of consensus on the consequences of the climate change is an issue”* T29. Some of the interviewees are having internal discussions to change the duration of their policies to be able to integrate a climate change timescale into their models.

Related to this, some interviewees highlighted that currently it is difficult to price risks, taking into account climate change for two reasons: (1) the issue of timescale and (2) because *“it is difficult for an insurer to justify one-year relationship with the same customers”* T31.

(2) Climate change challenges insurers on their catastrophe risk modelling expertise. 65% of participating companies declared to have started mapping and understanding the impact of climate change (Figure 19).



The remaining 35% have declared not to include climate change: *“to date there are no maps including climate change. We are exploring ways to integrate different types of climate change scenarios in these maps”* T47 or *“currently models are limited in their ability to integrate climate change scenarios: the catastrophe models use historical climate data and assume stationary scenarios in the future. But the industry is looking at this now, trying to integrate climate change into insurance catastrophe modelling, but it is quite limited at this stage”* T51.

Interviewees indicate there is a gap between the research currently being done in climate change and the needs of the insurance sector: *“to date academics are working on climate data/models, but without thinking of what the specific needs of the insurance industry would be. Wherefore, researchers do models but these are not linked to the insurers’ models. So, we need more dialogue and collaboration to make models useful for everybody”* T28. Interviewees raised the fact that there are too many differences between insurers’ risk models and scientists’ models. For insurers this represents a barrier to integrate scientists’ climate change scenarios into their own models.

Interviewees indicate there is a gap between the research currently being done in climate change and the needs of the insurance sector:

INSURERS' MODELS THAT INTEGRATE CLIMATE CHANGE

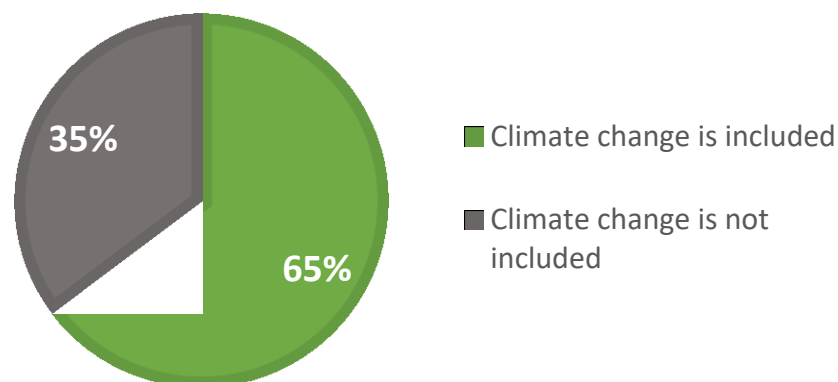


Figure 19: Climate change a challenge for insurers' models (34 responses)

(3) Participating companies indicate that climate change could be a way to provide innovative products and services to customers.



Such as targeted communication to improve their risk knowledge (on the risks insurance faces) and on how climate change impacts natural hazards: *“addressing future risks, taking into account climate change is a part of our DNA, of our responsibility”* T10.

6.2 The insurance industry’ understanding of nature-based solutions and the insurance value of ecosystems

Nature-based solutions are being considered as a risk reduction measure by the scientific community. The insurance industry is starting to be interested in eco-DRR measures. The interviews provide an up-to-date of the current perspectives on: (1) knowledge and understanding of the industry on NBS and on the concept of insurance value of ecosystems; (2) reflections on NBS/IVE’ integration into insurers’ models.

(1) Nature-based solutions and the insurance value of ecosystems are something new for the insurance industry with different emphasis (Figure 20).

Around 44% of participating companies have declared to know the eco-DRR concept but without any definition. For 28% of companies, the eco-DRR concept is known and well defined. The remaining 28% have declared not to know the concept. Some interviewees have argued the difficulty for the industry to understand the concept: *“the main issue is that NBS are not a well-understandable topic for the insurance sector”* T4. Several interviewees are focusing on a terminology change such as “co-natural management”, in the objective to understand NBS as “critical infrastructures” (labelling).

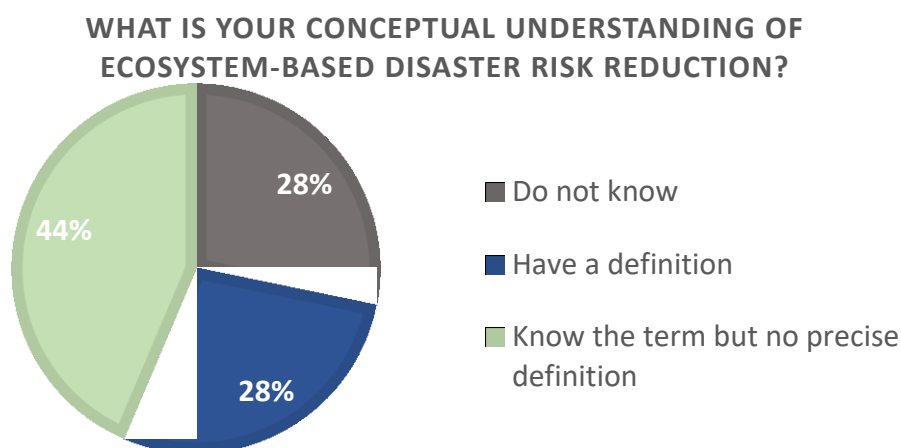


Figure 20: Current state of knowledge of Nature-based solutions for risk reduction (39 responses)



Concerning the concept of insurance value of ecosystem, 55% of companies do not know the concept. For 30% of the companies this concept is known and well-defined. 15% participating companies have declared to know the IVE concept but without any definition (Figure 21).

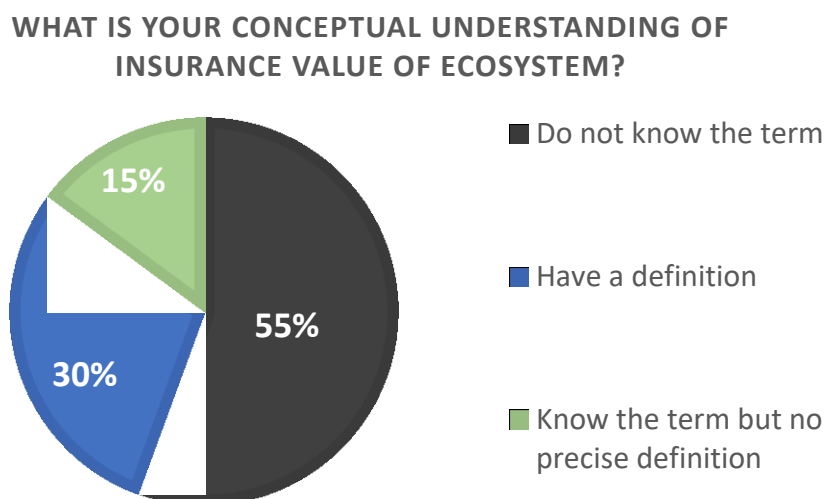


Figure 21: Current state of knowledge of the insurance value of ecosystems (27 responses)

All interviewees agreed that the IVE concept is complex, not easily understandable and confusing for the insurance sector: *“I am little bit surprised, I do not understand the meaning of insurance value of ecosystem. There is little bit as a confusion concerning this term. I would understand the IVE, as value of risk reduction.”* T10

For those knowing the term and having a definition, the IVE is understood as the comparison between the impact of natural hazards plus the costs of recovery and the avoided damages if NBS would have been implemented: *“the IVE could be assimilated to the added value of an ecological services made by an ecosystem, in vulnerability reduction of some issues, as an insurance for these issues and in the objective to give a monetary value to the annual value of damages avoided thanks to the presence of ecosystems”* T41.

Some of the interviewees have declared using other terminologies to talk about the insurance value of ecosystems. They highlighted that the IVE concept is too simplistic *“this term reduces ecosystems only at their insurance value to avoid damages and we forget the multiple benefits of ecosystems”* T11/12. *“I understand, nature might reduce insurance losses, but we do not call it “IVE”, but call it the “resilience dividend of nature”. The term “resilience dividend” is more than just insurance because from “resilience”, it is not just reducing your insurance*



premium, it is one way to make dividends from it [...] you continue to invest in nature or to maintain your ecosystem and the ecosystem continue to protect you in some ways (avoided losses) but you do not pay insurance for it, it is free” T43.

Some participating companies highlight that they have studied IVE in the past, but nobody (governments or private companies) have used the results: *“an internal team has already worked on this topic of insurance value of ecosystems” T29, “many projects were implemented in Romania and also at EU level on the (economic) value of ecosystems, but nobody integrated the results” T39.*

(2) The interviews revealed that NBS/IVE challenge insurers’ catastrophe modelling expertise and is variably integrated into models (Figure 22).

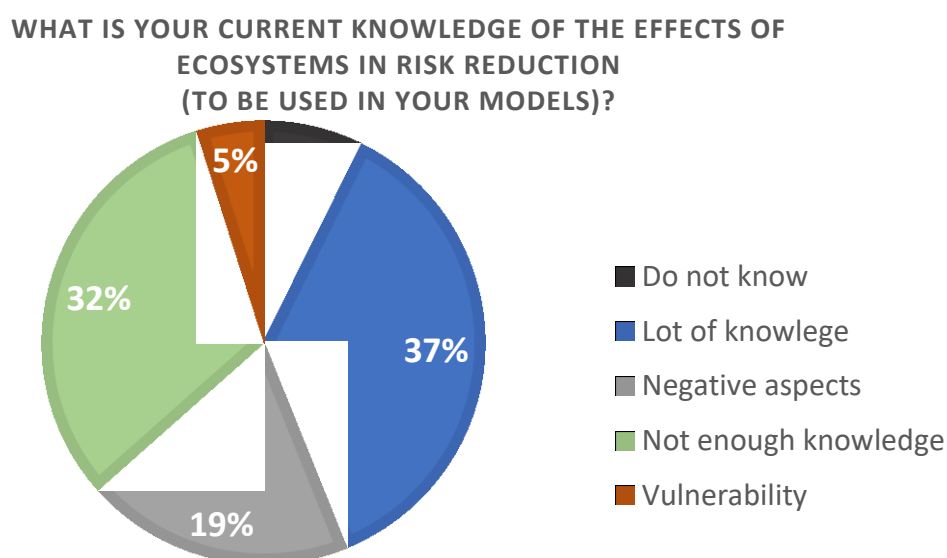


Figure 22: Current integration state of ecosystems effects into catastrophe models (41 responses)

For 37% of interviewees, the ecosystems role in risk reduction is known: *“we are incorporating the impacts of woodland into hydraulic models, which enabled us to model the physical impacts of planting on flood levels and therefore to estimate the economic value of associated flood relief benefits” T47.* Yet 32% of interviewees do not have enough knowledge to assess the impact of ecosystem services in risk reduction but are open to integrate it: *“hitherto, there is no model for calculating scenarios of risk reduction for different types of ecosystem services. We are at the reflection stage without any practical examples” T1 or “if it is recognized*



that a NBS can reduce dramatically flood risk, we are looking forward to integrate it into our models/scenarios” T29. For 19% of companies, ecosystems have negative impacts on natural hazards (i.e. ecosystems can fail, generate woody debris, etc.). For 5% of them ecosystems are vulnerable to natural hazards and climate change, which is a limit for modelling their role in risk reduction. The remaining 7% of interviewees do not know how to assess the IVE in their models. Some companies also acknowledge ecosystems can have at the same time positive and negative effects for DRR: “physical protection against winds, mitigation of the occurrence of hail. Negatives: increase in the frequency and/or severity of risks” T56 and “Or the trees fall and then the house can fall” T53.

On this knowledge point, the participating companies have been asked on their required knowledge and tools on NBS to define the IVE (Figure 23). For 37% of them, an increased exchange with the scientific community is necessary to improve their knowledge on NBS. Around 26% of participating companies asked for more data related to NBS.

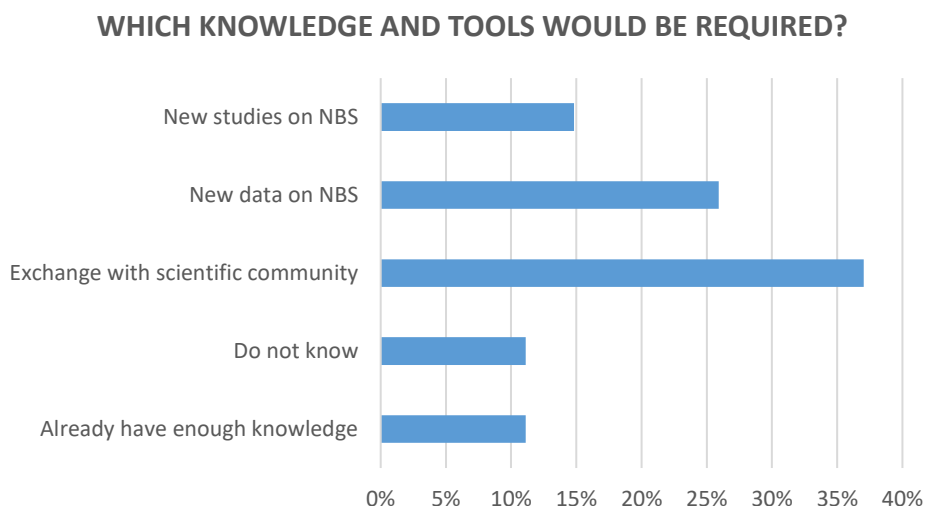


Figure 23: Current integration state of ecosystems effects into catastrophe models (27 responses)

6.3 (Eco)-Disaster risk reduction is challenging the insurance industry

A number of challenges exist to get insurers to participate in (eco)-disaster risk reduction. These challenges fall into four areas: (1) afford coverage for weather-related hazards; (2) increasingly interest in DRR; (3) changing business model; (4) changing people perception of the insurance industry.



(1) All participating companies have declared to adapt themselves to afford coverage for most of natural hazards (Figure 24).

38% of interviewees have declared meteorological hazards (storm surges etc.) as the main risks. While for 31% of them it's the hydrological ones (floods), 16% of them have declared geophysical hazards (earthquakes etc.) as the main risks. Finally, for 14% of them climatological hazards like droughts are the main risks. This shows the importance of the different hazards. Probably, the importance of hazards is different depending on the different locations. Insurers told us that: *"The problem of insurers in general, are not (individual) exposures by risk, but the accumulations that large events have, and these are the catastrophic exposures"* T55. Our interviews revealed that the insurance industry is challenged to cover risks and that they are also challenged by prevention: *"insurers are increasingly aware of their changing role and profession, from a role of compensation officer to a role of, simultaneously, compensation officer and role of advisor to limit disaster impacts. Insurers are increasingly involved in facilitating the disaster management process"* T2.

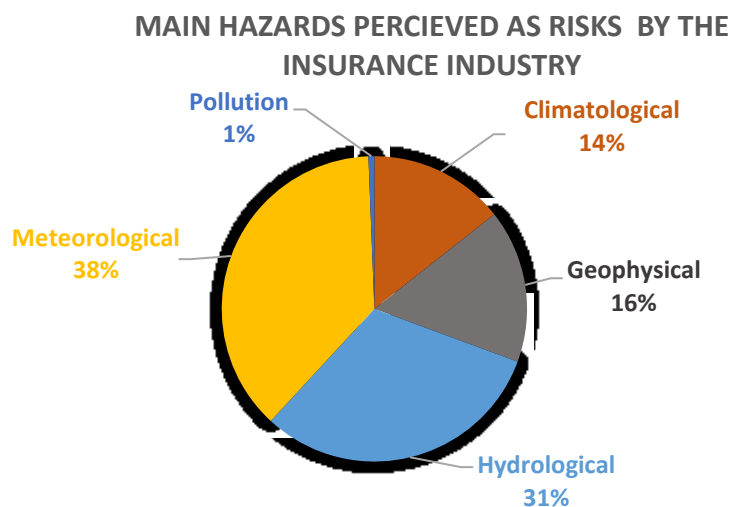


Figure 24: Main natural hazard following insurance industry perception (160 responses)

(2) According to some interviews with non-insurer stakeholders, a majority of insurers have not considered natural hazards to be an area in which they could intervene:

As an interviewee stated *"to date, insurers have not considered natural hazards to be an area in which they could coercively intervene in individual protection, in the same way as they do in fire or in theft with incentive tariff"* T3, or *"the flood risk insurance was developed from the vision that you should insure whatever you cannot control/bear yourself"* T44. Some insurers passed the responsibility to reinsurers, because the re-insurers are the most challenged by



natural hazards: *“Against natural phenomena, as there are not many, we will not have a measure of prevention. As we transfer the risk to the re-insurer, the truth is that we have little incentive as an insurer to take these indicators into account. It is the re-insurer that should encourage these preventive measures because re-insurers will have fewer accidents”* T53. On the contrary, some of them raised the issue that the insurance sector has no role/knowledge in water/flood management and thus, insurers could not intervene in risk management. Participating companies agreed that insurers have increased their interest in natural hazards impact due to high impacts on other branches such as motor vehicle insurances. The industry itself argues *“currently, we are in the financial assessment [of damages] and potential consequences, not in the adaptation stage”* T1. Some interviewees mentioned that both public (governments) and private (insurance companies and private owners) institutions *“have a rather passive attitude towards risk management”* T44.

The challenges are summarized in this quotation: *“the challenge is that less money is spent in DRR. Too much money is spent on ex-post measures, after disaster strikes (recovery), and not too much on ex-ante part, before disaster strikes (pre-resilience building and DRR measures)”* T10.

The interviews confirmed concerns with disaster risk reduction associated with potential benefits for both insurers and insured (societies) and pathways through climate change adaptation. Citizens’ risk awareness and perception that is fragmented across peoples and countries make it difficult for insurers to foster ex-ante measures. The responses further revealed that:

- Insurers, as social actors, have to make themselves and people more risk aware. *“We are working to improve our members’ culture by using specific program for members of insurance companies to incorporate in their culture and expertise the Sustainable Development Goals (SDGs), Sustainable and Responsible Investment (SRI) and the impact of climate change”* T50. Participating companies argue that, to increase their involvement in risk reduction, the risk awareness/knowledge/culture gaps in people must be bridged first. Insurers have faced people which have had damages once and think will never be flooded again, or forgot that they have had damages: *“People are aware of the floods during the flood events and a short time afterwards, but they forget about this problem too soon and cease to take protective or preventive measures”* T20. In many countries prevention measures are taken during the disaster event with ex-post measures. Greater risk awareness could help to build new services for insured and societies: *“insurers also play a role in flood risk reduction, for example in improving risk knowledge and awareness. However, insurance can play a more significant role in promoting a more ex-ante approach to risk by supporting risk reduction activities”* T51 and *“our objective is prevention and prevention measures (for climate related*



damages and thefts, fires etc.) to raise the public awareness on climate change adaptation and prevention” T30 or “make population aware of the natural hazard protection” T10. Participating companies highlighted the issue that people ask for grey infrastructures which limits NBS implementation: “A big problem is peoples’ perception about flood protection measures exclude renaturation measures” T18. Our interviews revealed that in countries without any flood insurance scheme, public authorities tend to incentivize households to invest in green measures. Public authorities have a role in creation of public safety standard for protective measures.

- Climate change is threatening green and grey protective measures. Some countries have faced severe drought, which has damaged dikes. There is a need to evaluate and model the impact of protective structures on risks: *“we need in the future to map, to identify, to size and to assess the state of these infrastructures. [...] it is complex to take into account into our models the impact of dikes on natural hazards. Concerning ecosystem services, it would be difficult too” T11/12. “Natural infrastructures are the future of risk reduction [...] but those solutions do not work for every or extreme hazards. Hybrid measures are sometimes most adapted” T32. “I would be interested to know how they [global organisations] are using predictive tools such as flood modelling, climate change modelling for strategic planning for the longer term, to channel their efforts and finance to reduce risk through Europe” T48.*
- There are ongoing processes for incentives to encourage implementation of protective measures: *“insurers have to improve their mitigating role to reduce the hazards” T48 and “the better defences, more resilience and therefore the insurance will be less expensive” T33. “Well, think of the health sector. Prevention is always better than the cure.” T45. According to all participating companies, incentives are based on people’s awareness, which differ from those that want to implement protective measures and who are not risk aware. All participating interviewees agreed that people’s willingness to pay is the main challenge for the industry. In market-based insurance schemes, incentives focus on premium discounts: “insurers interest is to incentivise with lower premium and pay a little bit more to pay for better reconstruction” T33. Other interviewees highlighted the limit of premium discounts “If you are not able to measure the positive effects of having green infrastructures in place, then you are not able to reward the clients that invest in such infrastructure – and you do not increase the awareness of the insurance sector neither” T28.*



(3) Changing business models towards eco-DRR is the biggest challenge for the industry.

For non-insurers stakeholders the insurance industry must understand that DRR is useful for its interests, e.g., as a way to maintain insurability, to protect their ability to provide coverage: *“new business models as new society contracts. Insurance companies will develop their business on both reducing their own risks, reduce society’s risk and thus, enhance society’s resilience”* T32. According to participating companies eco-DRR is an interesting and additional opportunity: *“At the moment nature-based solutions are something that is starting to be part of the way the insurance sector is supporting the issue of climate change”* T28 and *“learning more on a climate-based approach in the insurance sector is clearly an important target for strengthening our position in the market, as well as for our image”* T38. Our interviews revealed that now few insurance companies are undertaking research in eco-DRR and to see how NBS could be integrated into the current business model: *“how could you develop business models that actually use nature services as an investable asset?”* T31.

(4) Some participating companies raised that the insurance industry faces bad public perception, which has to be overcome if they want to communicate on disasters and moving away from this people’s perception:

Insurers comment how *“when we are communicating this, people think that we only want to generate more business. When insurers do this, people just think insurers want more premiums”* T46. Some of the non-insurers stakeholders that were interviewed highlighted that insurers are not interested in DRR, or to incentivize prevention in natural disaster, or to invest in NBS: *“I think the insurance sector is far from any interest in investment of risk reduction measures or incentives for property owners by the insurers”* T8.

6.4 Roles of the insurance industry in supporting (eco)-disaster risk reduction

In general, insurers consider (eco)-disaster risk reduction as fundamental to improve socio-economic resilience to natural disasters and transitioning to business models based on ex-ante protective measures.

6.4.1 Insurers as co-developers/innovators

The insurance industry is already communicating on climate change adaptation and disaster risk reduction targets. *“The public reinsurance fund currently finances certain preventive (communication and awareness raising) actions like brochures, research projects, etc.”* T52.

For participating companies, the insurance industry could have a role to foster more sustainable land use planning, building codes, resilient protective infrastructures implementation and legal changes: *“we have to lobby more for sustainable land use planning”* T6. Some companies are starting to be interested to work with engineers (the building industry)



to build back/before better, or to provide sponsorship for DRR activities. *“Anticipation and communication are the cornerstone of any insurance strategy”* T1. The insurance sector argued that this interest increases: (1) due to future uncertainties related to (bad) land-use planning and urban sprawl in high risk areas (with more valuable items and buildings and more disasters); (2) the issue of premium price in those areas; (3) social issue of expropriations of citizens; (4) to decrease their footprints and improve their image (greening business).

6.4.2 Insurers as providers

The insurance industry is starting to underwrite green protective structures and there is a willingness to increase the penetration rate. The industry however needs scientific evidence of ecosystem services in DRR. The interviewees indicated that:

- 1) **Concerning data exchange, there was agreement that there is no wish to be data providers** for two reasons: first, because insurers' data is confidential (for competitive reasons and because it contains personal data) and second, because insurers want to provide their expertise in risk management to society. Most of interviewees would like to have more data on ecosystem services (see Figure 22).
- 2) **Insurance companies can increase their role in awareness raising.** The case of CCR and the Fund Barnier and how it could be extended to other countries was raised: *“In France the Barnier Fond uses the money collected from insurance for prevention”* T52.
- 3) **Insurers, as social actors, provide risk management services to customers.** According to interviewees, DRR opens the possibility to offer new services to customers on the prevention side, to warn their clients in case of meteorological alerts, on the recovery process, with selections of engineers to build back better. Insurers emphasised that in the future premiums will increase in high risk areas due to the increase number of people living in those areas and the value of exposed assets (items and buildings) could largely increase. Insurers need to better assess their risk portfolios with well-defined premiums and specific policies in their objective to increase coverage and to stay solvent. The participating companies revealed the importance of affordable coverage without underwriting as a social priority in some countries, since natural hazard insurance is a mandatory requirement to obtain mortgages.

The extent to which insurers have been underwriting risks varies from country to country. According to participating companies from market-based insurance schemes, preventive measures are required for premiums discounts: *“if you have prevention measures it is cheaper for you, and if you do not have prevention measures it is more expensive”* T6 or *“We offer discounts if clients take risk mitigating measures”* T44. These insurance schemes used risk-based premiums considering exposure and protection for pricing the premium Interviewees



declared facing difficulties to price the premiums for buildings that are located in high risk areas. Participating companies with mandatory insurance schemes that do not have risk-based premiums indicated that in the future it could be possible to create financial incentives: *"If the house is on stilts, can this create financial incentives? I will answer very clearly: yes [...]. These preventive measures can be made obligatory in the contracts, in case of non-compliance with these measures, the insured will not be reimbursed"* T2 or *"To date, the insurance company is involved in the development of green infrastructures with the objective to prevent risks and not for this to be integrated into premium calculations"* T28. However, some of them argued that there is no real risk-based premium due to market's rules. It is a premium purely calculated for profits and uncertainties.

Precisely on the question of the integration of prevention measures into premium calculations, all interviewees indicated that currently this is not taken into account: *"we want to introduce more specific elements into premium calculations. Concerning the question of ecosystem services, it is really important to integrate nature-based solutions into premiums. Insurance companies will be able, thanks to new data on ecosystem services, to design new insurance products: a pay as you live insurance"* T50. Other interviewees raised some potential negative impacts of eco-DRR on premiums: *"Eco-DRR could reduce premiums. But it can generate a negative effect. Take the example of a house located in a high-risk area, in this area you implement NBS to reduce risk. Thus, the value of the area increases due to landscape aspects and feeling to be protected by natural infrastructures. People will be attracted to live in this area, notably high-income people, which needed high insurance guarantees and by the way they will pay higher premiums. Not necessary high premiums for natural hazards but to cover their assets"* T11/12. Some interviewees highlight the limited success of premium reduction. Interviewees indicated that it is difficult to convince/monitor homeowners who have implemented protective measures (people flooded once and think never again, forget it and refuse/forget to protect themselves). At catchment scale (see § "insurers as partners"), insurers argued that there is no sense of belonging and willingness-to-pay: *"It would be dedicated to have the citizens' willingness-to-pay for premiums that insure ecosystems located upstream. This is a good approach but the insured will say "I am not going to pay premium for an upstream forest not in my territory"* T1. Some interviewees compared the insurance role in theft/fire prevention to the potential role of insurance in natural hazards prevention: *"As the example of policyholder which implements alarm system against thefts or fire, the insured will receive a premium reduction. It would be implemented for natural hazards. It could be possible to create partnerships with private societies to reduce NBS implementation costs and to reduce premiums"* T5 and *"if you check in your neighbourhood how many houses burn in the last 2-3 years? Maybe none. And how many houses were affected by storm or water? It is quite a number of houses affected"* T6.

There can be cases when it can be easier to implement these types of premium reductions. It is the case of agricultural insurance in Spain, where *"There are already bonuses for*



the case of application of preventive measures” T56. It is, nevertheless, limited to certain crops, hazards and protective measures like protections against hail and wind barriers in horticultural crops (ENESA 2018).

(4) Insurance of (green) protective structures is being considered by insurance companies in three ways, as (i) a current liability and business interruption issues; (ii) as a core business opportunity; (iii) as a non-insurable asset.

i) Most of participating companies insure protective structures for civil liability and indicated that most of those protective structures are not insured (governments insure those structures themselves). Concerning natural areas (forests, marshes areas), interviewees specified that it is insurance for civil liability, business interruption and not for damages, or for the ecosystem itself: *“If a wetland area with high diversity of species and services is destroyed or damaged by a natural hazard, we cannot insure it as damage [...] I have never been asked to ensure an ecosystem, I insure an economy within an environment area” T7. Some interviewees justified that landowners are more worried about their civil liability than to be insured for damages: “as landowners we never use the term “ecosystem” to insure our marshes/ponds. For us it is something new, you raised our awareness of the additional role of ponds in risk reduction” T42. Other insurance companies argue that, with knowledge improvement on forests/marshes disaster risk reduction, landowners will need to have new dedicated policies (civil liability in case of failure due to/or not to bad management).*

ii) Most of the participating companies understand that natural hazards or man-made activities (deforestation) could affect ecosystems and their IVE. Interviewees are recognising their impacts/dependencies on ecosystems and the need to imagine new markets to insure nature-based solutions. Some companies are setting up dedicated policies (parametric insurances) and are considering natural infrastructures as critical infrastructures: *“Example of the salt marshes in the state of New Jersey, we are looking at the value of those salt marshes in how much salt marshes are reducing the risk of storm surge flooding. You take into account cost-benefit analysis of grey infrastructure (sea walls) and green infrastructure (nature, environmentally-friendly nature)” T43. Other insurance companies are interested and asked for more “connection between insurance and scientists, to demonstrate the impact of nature on natural hazards [...]. It would be useful to assess how ecosystems reduce the insurance losses for various scenarios” T51. The interviews revealed that, if one company wants to insure NBS through parametric insurance, its solvency must be required, and risks have to be understood, if not, it would not be allowed by the Solvency II Directive: “it is too far away from the core business and not regulated by the legal framework” T6. Other interviewees indicated that the multiple benefits of natural infrastructures could be linked to both life and non-life insurance*



products: *“ecosystem services have multiple benefits; it could be possible to combine social and natural hazards insurance products”* T50.

There is a need to develop agricultural insurance and new relationships with landowners. Landowners argued that *“insurance companies refuse to cover natural disasters on agricultural land and the farmers generally do not choose to insure their crops”* T40. The insurance industry is facing barriers to encourage landowners to preserve ecosystem services, because farmers want to survive (produce foods in poor countries) and not to use their lands for eco-DRR: *“The implementation of green solutions (as more room for the river) is difficult due to local interests (agriculture)”* T34. In addition, landowners themselves do not want to sell their lands for DRR *“A common problem is to provide space for meanders due to untouchable land ownership in Slovenia”* T18.

iii) For the remaining participating companies, natural infrastructures are currently protected for their cultural heritage aspects and not for their DRR roles. Some interviewees do not think it is possible to insure natural infrastructures: *“Can we ensure ecosystems against particular perils? Can an insurance company provide coverage for these perils? Then I must say I am not aware of it. It is an interesting concept, but I think that does not exist”* T10. Or they indicated that it is a too small market for them.

6.4.3 Insurers as investors

Insurers, as institutional investors, require clear demonstration of the disaster risk reduction benefits and a viable business model to invest in natural infrastructures.

- 1) Participating companies declared the need for Sustainable and Responsible Investments (SRIs), with the objective: (i) to decrease their own risks and costs; (ii) to diversify their investments through environmental governance.

For non-insurers stakeholders, they agreed to demonstrate to the industry the impact of businesses on ecosystem services and the impact of ecosystem services on businesses: *“in general, these business people do not consider the value of the ecosystem: they focus much more on the purely financial and less directly on the environment. The two domains are not so much connected at present”* T51. Our interviewees came from non-life insurance and agreed that *“investment in NBS is more linked to life insurance than non-life insurance management investments”* T41.

- 2) The interviews revealed that return on investments from non-life insurance is positive: *“investments are useful for the insurance sector. Take the example of the Holnicote project. The restoration of the upstream floodplain costed £163 000, to protect 98 properties, the insurance value is estimated at £30 million. None of these properties were affected by flooding.”* T47 or *“the timing need to invest and to pay upfront, but the benefits will occur in the future when there is another flood and your loss will be reduced”* T31. *“Make the case, that protection is easy to be implemented, no too expensive. It is a*



nature assurance system, the role of nature in helping resilience and the need for more hybrid strategies, as new way to protecting ourselves. We have to make the good combination: economically viable case, financially attractive for investment based in NBS" T10.

- 3) The participating companies highlighted the need for long-term investments (i.e., natural infrastructure projects, monitoring of those projects, and raising awareness etc.): *"the insurance industry could have a key role to finance studies on NBS in risk reduction" T29 or "long-term monitoring of natural infrastructures is lacking, it could be financed by insurance companies and useful for the company through long-term data/information collection" T32 or "we are willing to implement DRR measures including NBS's but there is much more to invest to increase the awareness and to change the mentality both of other public institutions and private entities" T34.*

Most of the interviewees agreed on the need to implement market surveys to compare the costs of natural hazards recovery, with or without the presence of natural infrastructures: *"Research and Development (R&D) are important; our company is a member of a task force of the Ministry of Ecology to do cost-benefits analysis of protective structures" T1.*

- 4) Participating reinsurance companies argued to intervene into the bond markets, with a strong willingness to issue green bonds, to participate into sustainable finance and circular economy. The interviews indicated that the private sector is willing to participate in public investments (bonds), which help society resilience, as a kind of cooperation (partnerships). Some of interviewees explained that the insurance industry can ensure (natural) protective measures: (i) during the risk building process (see § insurers as providers) and (ii) ensuring protective measures as an asset through catbond markets (as an insurance for governments' protective structures: *"if it was an earthquake that damages the seawall and it needs to be repaired to continue to do its job to protect the city from storm surges and floods, there will be a pay out to repair it. What kind of insurance or risk finance will you take? It may not be traditional insurance but better suited insurance such like CAT bonds. CAT bonds cover all different things though, not only protective infrastructures" T43.* Our interviews revealed that green bonds could be used to fund research on climate change and eco-DRR. Almost all interviewees agreed to well define economic interests of nature-based solutions to attract investors: *"Without economic interests, investors will not come" T2.*
- 5) The interviewees also revealed some limits for the insurance industry to invest in disaster risk reduction measures. Participating companies highlighted that they would not invest in NBS to protect people covered by another company and they do not want to be liable in case of failure: *"it would be possible to finance NBS but financing these areas will be beneficial to numerous insured and not only people insured by our*



company” T29. The second limitation is that NBS involve long-term investments and potentially long-term contracts, foresights that are difficult to be seen by the industry: “we could for example close a long-term contract, like mortgage on a house, it would become easier to also be active as an investor in risk mitigating measures” T44 or “Financing ecosystem protection and preservation is a complex issue for the insurance sector” T3. Another limit is that investments in safety/security is not the insurance company’s role, but the government’s. Our interviews indicated the lack of knowledge to see the cost-benefit or the eco/monetary co-benefits of NBS: “Financial aspects are one of the main obstacles. If you are not able to measure the positive effects of NBS on something that will (maybe) not happen, this is a useless discussion because you do not understand what are the investment items and therefore it is impossible to create financial instruments” T28 or “NBS interests us, but the lack of practical implementation is an issue” T29. Other interviewees declared that insurance companies will never invest to lower the risk of their customers: “It is a common question: can the insurer not invest to lower the risk? The answer is no, because when the risk lowers, the premium lowers” T46.

Insurance companies also highlighted the importance of regulation of investments: *“we invest in certain products, but that is often regulated by the supervisor” T53. If investments want to be changed, new regulations will be needed.*

6.4.4 Insurers as partners

Insurers, as social actors, are also institutional partners for society’s resilience. Increasingly, insurers are starting to see themselves as social partners for insured people and for other stakeholders. Our interviews highlighted that the insurance industry is changing globally towards new partnership roles in risk reduction, as an additional -non-traditional - role. Through this partnership role, the insurance industry acts simultaneously as a co-developer, a provider and as an investor: *“NBS in risk reduction is an interesting subject to the insurance industry. Simultaneously, as an insurer, in the objective to know how/if NBS can reduce our own risks and as a society actor, the company’s responsibility to cope with climate change” T29 or “interesting relation between risk reduction, benefit generated and reinvestment into NBS, it is virtuous” T5. The responses further revealed: (1) the on-going need to exchange with scientists, private companies and governments towards society resilience to disasters; (2) partnerships with stakeholders involves in eco-DRR.*

- (1) Participating companies argued the need to foster partnerships with governments and scientists on preventive measures, with the objective to unlock insurers as investors and partners (financing and promoting policies). Insurers highlighted that



they could intervene before, with prevention measures and after, with build-back better measures. Some interviewees raised the need for public-private partnerships (PPPs) with governments to encourage the integration of climate change impacts into protective measures design, or to link public finance to protective measures and risk transfer: e.g. in France, *“The current PPP links risk transfer (insurance), financing protective measures (Barnier Funds) and data exchange (ONRN)”* T41.

Precisely on the question of nature-based solutions as risk reduction measures, our interviews revealed the need for more exchange with scientists: *“For the insurance industry, it is impossible to work alone on the eco-based DRR, we have to work with scientific partners to have the scientist’s credibility of the positive impacts of these areas”* T29 or *“we made a lot of investments in the scientific side, we are working with people which have deep knowledge on ecosystem services in risk reduction”* T13 or *“The IVE is obviously the current example of the increasing involvement of the insurance sector in DRR and environmental accounting aspects (natural assets, protecting and accounting for it), and raise awareness through new taskforces”* T51. Also, more partnerships (as investors and as providers) with engineering industry and land-use management: *“to develop insurance projects on the role of resilience and buffers in nature, with engineers, architects and designers, the insurers will want to finance those projects and cover them”* T51, or *“we could translate natural based solutions as an example of best field water management practices or best practices examples to reduce flooding and related risks”* T18.

Participating companies declared their interest to work in PPPs with upper/lower municipalities at catchment scales through pooling of investment funds for eco-DRR: *“We provide help to construction industry: how to design houses to cope with flood risks? We are using NBS at the catchment scale (benefits of mangroves, negative impacts of deforestation). We work only for specific sites with specific models for these sites, if it works well with nature, we will use it, or we use hard engineering in order to find the best solutions, but according to the English policy we have to incorporate green/NBS solutions first and then go to harder engineering after if a NBS is impossible”* T48. Other interviewees commented on the multiple benefits of natural infrastructures, (i) for the insurance industry, with the economic path and the human part: *“insurance companies are mostly involved in risk reduction, both for one part, the economic path, to prevent damages and pay less claims and second, the human part to avoid flooded houses. It is a win-win situation”* T30. (ii) and for society resilience, as enablers for restricted public budgets: *“the ability to demonstrate that NBS projects costs are outweighed by the benefits is becoming ever more important for restricted budgets or limited funds”* T47. Participating companies argued to foster



municipalities to invest, through PPPs, in DRR measures and in return financial advantage for citizens.

- (2) Most insurers see protective measures projects as a potential opportunity for partnering for reasons such as: (i) partnerships with financial institutions and cities to finance/incentivise eco-DRR measures; and (ii) partnerships at catchment scale for eco-DRR implementation.

(i) Participating companies argued on the need to work with banks and that they are currently drivers in change for disaster risk reduction and nature-based solutions implementations. *“For your NAIAD case, NBS are particularly clear for a bank point of view but not so far for the insurance sector”* T50. Some insurers highlighted that bank and insurance companies are linked (see § “insurers as providers”) to finance house restoration into a green and mitigate one: *“a bank can give you a loan to buy a house and a part of this loan can be dedicated to restore your house into a green one. So, you will become the owner of a green building which can reduce your insurance premium, using data from protective elements related with risk reduction”* T51. *“We are interested in working with other organisations, the multilateral lenders for example like the African Development Bank, UN, the European Bank for Reconstruction and Development etc., because they are drivers of change in developing countries to look at disaster risk assessment and to disaster risk adaptation/resilience. They are investing money to reduce their risks and NBS could be a part of that (lend government money to do things)!”* T48.

The bond markets (see § “insurers as investors”) are examples of public-private partnerships (PPPs) with cities and insurers/bankers: *“The intention is to develop formal financial investment to develop natural capital for these cities. As the example of Turin 2016 has issued a green bond for reforestation and greening of public lands. It is an example of PPP to finance a green project”* T50.

(ii) Most insurers argued that catchment scales/river basins are the ideal scales for partnerships dedicated to mainstreaming value, restore, and maintain natural infrastructures for disaster risk reduction. *“These two types of prevention measures (individually and globally) are the cornerstone of national prevention measures”* T2.

Our interviews revealed that the insurance industry already understands the multiple benefits of PPPs dedicated to natural infrastructures.



6.5 Relationships between the insurance industry and the European Union for DRR

In general, insurers consider the European Union as fundamental to scale up socio-economic resilience to natural hazards through policy/regulatory frameworks and to foster a greener economy.

The responses further revealed:

- (1) There is a need for the same level of economic security for all European citizens (same insurance coverage). The protection gap is the EU trigger point, redefining premiums to more affordable ones, considering eco-DRR could increase the penetration rate in all Member States.
- (2) There is a need for better defining the use of the European Solidarity Fund by Member States according to their national insurance schemes.
- (3) Some interviewees indicated the need for mandatory national insurance schemes. *“Lack of clear European strategies concerning the legislative policies to reinforce a mandatory insurance system”* T26 & 27. There is a need for policy incentives and a clear code of conduct to encourage and orient green/risk reduction investments by insurers. There is a need for better standards and data. Participating companies highlighted that the Solvency II Directive penalizes long-term investments and the lack of appropriate nature-based solutions labels impacts investors’ confidence. In the future, this could unlock financing and creation of new contracts, strengthening insurance position in the market and improve their image. *“Currently, the Solvency II Directive penalises long-term investments, which is bad for NAIAD, it is a contradiction and a current debate on new visions for long term investments. There is a need to integrate SDGs criterion into this kind of policy, it is the way to introduce the environmental criteria into business models of insurers. Our proposal is to change the concept of financial intermediaries which are currently focused on short-term investment, to change it into long-term investment. This will bring clear demonstration for investors to mitigate climate change impacts, social and environmental issues. Long-term/long-mid-term investments are the skeleton of good economy, of good development of the European economy, it is really important for us to switch to this way. The European Commission should adopt new laws on this way.”* T50. Or *“It is a very good point to mention long term investment in the design of Solvency II, which determining the risk-based Solvency Capital Requirement (SCR) for firms, based on an analysis of risks over 1 year only. Solvency II and the Prudent Person Principles require that insurance companies should have an appropriate model and expertise in different asset types, and that they should not invest in areas where they lack knowledge and expertise. It is quite a rigorous structure but incomplete”* T51.



- (4) A number of good examples or ways to develop disaster risk reduction have been indicated within our interviews such as: (i) the idea to use the European Sharing Presidency to increase visibility and recommendations of good practices for NBS, as an advantage for insurance companies; (ii) insurance coverages are mandatory requirements to unlock European funds. It is a functioning solution to increase insurance coverage of enterprises; (iii) the National Rural Development Programme⁵⁶ provides: compensation for farmers who have suffered economic losses; financial support for administrative costs and interest loans. However, some interviewees have raised the lack of mutualisation awareness, willingness to implement this fund.
- (5) There is a need to clarify the articulation between climate change adaptation, disaster risk reduction, and ecosystem preservations policies. Some interviewees raised the question: Could European regulations for natural protected areas (e.g., ZNIEFF or Natura 2000) limit NBS implementation? How to link cultural heritage and disaster risk reduction? *“Currently we are preserving ecosystems for their heritage aspect and not for DRR roles”* T7.
- (6) There is a need to find European wide financial solutions. Interviewees raised the idea to use a CCA fund to finance NBS.
- (7) There are insurers’ demands for recommendations from the European Union toward disaster risk reduction principles, new business models and to clarify the insurers’ scope of interests. *“A recommendation from the European Commission would help implementation in practice of new models of insurance policy that includes green solutions”* T38. *“European regulations could influence the private companies to start promotion of NBS solutions for water security as reduction of premiums for houses/farms/agricultural lands”* T39. *“The impact of the insurance value of ecosystem will have a greater impact if the European Commission implements new rules! If you want to have a well-functioning business model, with a clear code of conduct, every part of the insurance business will orient to this SDGs, SRIs approaches/investments [...] We are strongly in cooperation with the High Level Expert Group promoted by the European Commission, to develop proposal to reinforce the process of introduction of sustainable finance and circular economy into the European legislation”* T50.
- Participating companies asked for implementation of an NBS EU Directive, for bottom up approach in DRR: *“EU Directive to make people aware of their problem. They will act on their own ideas; it is an easier road to implement NBS. As the example of the European Floods Directive”* T6.

⁵⁶ NRDP (2014-2020), sub-measure 17.2, mutual funds for closing insurance policies for climate events.

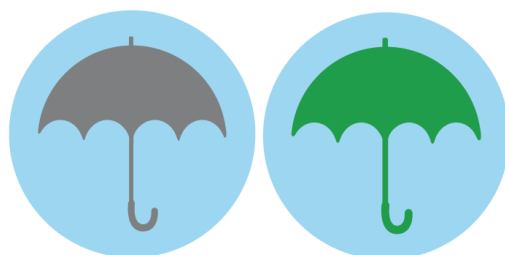


6.6 Main findings from the interviews

Climate change brings new opportunities for the insurance industry, but it also poses novel challenges

As providers of insurance services, the industry faces the challenge of how to price and model the impact of climate change on natural hazards. As suppliers, due to its long-term expertise in risk transfer the industry has also an opportunity in these challenges to offer innovative products and services to its customers.

1.



2.

The insurance industry is already raising interest on nature-based solutions and the insurance value of ecosystems

As providers of insurance services, the industry can develop best knowledge in collaboration with stakeholders to assess the protective value of ecosystems, by incorporating the dynamic nature of nature-based solutions. The industry faces a knowledge gap in understanding ecosystems functions and processes to integrate these in their natural catastrophe models.

Current moves towards preventive measures offer new roles for the insurance industry, encouraging changes in established roles and procedures

An important challenge is to increase the involvement of the insurance industry in DRR and prevention. Different approaches will be applied depending on whether these are publicly-driven, collectively-driven or privately-driven systems.

Examples of insurance roles:

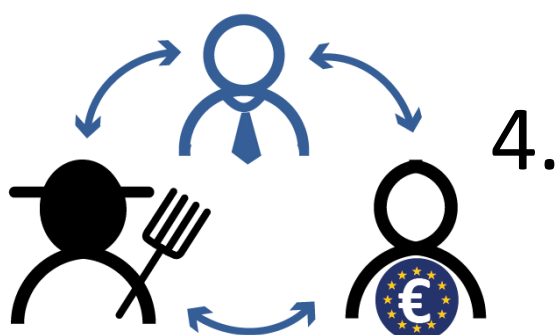
- As new service providers, the industry will look at data, and the potential for new services to be offered based on new visions on insurance from green protective measures. The reinsurance aspects (public fund vs. private companies) will be a key issue in the strategy design as providers of new eco-insurance for DRR in different countries.

3.





-
- As investors, the industry could spur investment when there is clear demonstration of DRR benefits and these fit with current regulation. Long-term investments have to take into account their risk appetite, their regulatory framework and competition issues within the sector.
 - As partners for other parties, the industry can help to communicate and thus, raise awareness on climate change adaptation and disaster risk reduction. Communication is essential to increase risk awareness. Thus, as partners, the industry in its interactions with scientists, governments and financial institutions can help to incentivize preventive measures (particularly at catchment scale).
-



Regulations and the essential role of the European Union to stimulate new roles in the insurance industry

As the main institutional partner, the European Union needs to support the industry in fostering new ways to a greener economy. The EU has a key role because new regulations can help incentivize the adoption of NBS for DRR and CCA.

Current barriers:

- Lack of awareness in the insurance sector on the potential of green preventive measures.
- Limited national disaster insurance systems.
 - Regulations (e.g. Solvency II Directive) restrict long-term investments, when it should encourage them.
 - Lack of well-articulated regulation

New incentives:

- A new Sustainable finance Strategy of the EU.
 - A new Nature-based solutions Floods Directive.
 - Developing NBS standards based on H2020 projects.
-



7. Recommendations and conclusions

NAIAD addresses disaster risk reduction, climate change adaption, nature-based solutions and insurance in a more comprehensive way than previous related topics. 61 interviews have been held, using ways to speak common language between scientists and insurers.

Studying European natural hazards insurance systems highlighted differences and similarities of risk management and adaptation strategies considering ecosystem as a real reliable means to reduce risks.

Implementation of NBS will take time and may take longer in some countries depending both on the existing policies, political frameworks and insurance schemes. Moreover, there is no universal solution, due to Member States specificities, insurance penetration rate and natural hazards/protective measures portfolios. The implementation of incentives varies across European countries, deductibles or premiums incentives depend on the insurance scheme choices. The insurance industry is one part of the network of stakeholders, all of them growing their interest in preventive measures (e.g., eco-DRR, promoting risk awareness, improving building standards), but these efforts are still fragmented. To achieve European Commission NBS objectives, differences among insurance schemes, opportunities and barriers, need to be considered to integrate ecosystems as risk reduction measures.

The insurance industry, as one of the main stakeholders, is increasingly involved in and challenged by climate change adaptation and disaster risk reduction. As co-developers, providers, investors and partners, the insurance industry is addressing climate change and disaster risk reduction issues.

The insurance industry is already contributing significantly to risk management of natural hazards events. The growing role of the insurance industry in DRR recognizes a new challenge to be addressed. More and more insurance companies invest in innovative climate change, ecosystem services, eco-DRR studies, projects and bonds. It is a way to support changes to ex-ante based new business opportunity, through new insurance contracts (e.g., parametric insurance for ecosystem preservation etc.), new investments strategies (e.g., sustainable investments with green/blue/cat bonds etc.), greening innovating ways, new environmental partnerships and active reduction of its own environmental impacts. New ideas are currently under development and consideration.

Recommendation 1: The European Commission has to consider insurance schemes' differences to reinforce and create harmonized linkages between CCA/DRR' policies and insurance businesses. New policies mainstreaming eco-DRR measures and insurers' contribution could be based on public-private partnerships (PPPs). Thus, it is an opportunity to promote risk



awareness, risk reduction and to bridge the knowledge gap in the insurance industry on preventive measures.

On NBS/IVE concepts understanding in the industry,

The IVE concept has to be detailed and defined by the EU to avoid confusion in the insurance industry. Raising these concepts highlight misunderstandings and confusion. On the one side, this is due to lack of knowledge from the industry about these concepts (e.g., raised the issue of concept integration from one to another), since it is a somewhat confusing concept (e.g., different understandings from one person to another) and on the other side, other terminologies already exist for the same or very similar concept (e.g., resilience dividend of ecosystems). The EU has also to find ways to mainstream and to support NBS implementation and to avoid the multiplication of terms related for one concept through poly changes (e.g., natural infrastructure for green infrastructure, or green infrastructures for nature-based solutions).

At the industry level,

Insurance industry is working on exploring synergies, linking ecosystems preservation, eco-DRR and disaster insurance. Clarifying, defining and integrating ecosystem co(st)-benefits into the core insurance business is the emerging way to tackle impact of natural disasters in the future. The insurance industry has a strong role in risk perception influence (sensibilization, alerts, prevention, incentives etc.) which could lead to drawing up intelligent coverage concepts and new products mitigating natural disaster losses.

However, many barriers identified in this study cannot be addressed by the insurance industry alone. We encourage insurance companies to increase and continue their involvement in nature-based projects before any disaster strikes. Proactively engage with governments and create partnerships to guide large scale risk management activities, increasing territorial protection resilience. To support advancements in catastrophe risk models and cost-effective assessment of NBS in strong partnership with the scientific community.

Recommendation 2: The interviews revealed the need of NBS Floods Directive based on the same principle of the Floods Directive (risk maps integrating protective measures, greener risk financing). The interviews revealed the need for clear European and national roadmaps for sustainable insurance. However there are divergent opinions on the idea of an EU imposition. This is linked to the EU proposal to foster insurance industry in DRR.



At the natural, agricultural areas,

The interviews results allow us to discuss the Tipper 2017 proposals on farmers paid to maintain their agricultural lands, as NBS, for DRR. Farmers are more challenged by social issues than environmental preservation and DRR.

Recommendation 3: Projects like NAIAD, scaling-up experimentations, testing and demonstrating the applicability of NBS, challenge the EU on the policy interactions between NBS implementation and current protected areas (Natura 2000, ZNIEFF etc.) The EU could base future policies on NAIAD standards for NBS implementation. The key challenges are to determine the insurance value of ecosystems and to assess the multiple benefits of DRR whether disaster strikes or not. We should face the undergoing rapid changes by increasing integrated approaches.

Limits and biases,

The Grounded Theory method is a rigorous and tedious method, especially due to the volume of data. Concerning data collection, it was difficult to follow the questionnaire framework very strictly due to the semi-structured format and time consuming nature of some of the questions. Nevertheless, NAIAD taskforce avoided interference with the data collection in as much as possible with the objective to stay neutral.

These interviews are self-reported opinions and perceptions, they may be mistaken, deeply biased or even misleading. Therefore, the quoted responses need to be placed into a wider context. Indeed, we were asking (re)insurers about their perceptions on topics they know little about and work little in, so it is important to keep a certain distance to these results.



8. References

- Agency, E. E. 2017. Preparing Europe for climate change: coordination is key to reduce risks posed by extreme weather. . European Environment Agency.
- ANIA. 2017a. International Day for Disaster Risk Reduction 2017, Cosa fanno le assicurazioni per prevenire i rischi e proteggere i cittadini? ANIA,.
- ANIA. 2017b. Trends focus assicurazione incendio e catastrofi naturali delle abitazioni civili. . ANIA,.
- Bacani, Butch, Nick Robins, and Jeremy McDaniels. 2015. Insurance 2030 - Harnessing Insurance for Sustainable Development. . UNEP FI Principles for Sustainable Insurance Initiative.
- Barbier, Edward B. 2013. Valuing Ecosystem Services for Coastal Wetland Protection and Restoration: Progress and Challenges. Resources.
- Baumgärtner, S., and Sebastian Strunz. 2014. The economic insurance value of ecosystem resilience. Ecological Economics.
- Beck, M.W., G. Franco, A. Guerrero, C.J. Ingram, S. Narayan, B.G. Reguero, C. Shepard, C. Thomas, D. Trespalacios, and P. Wilson. 2016. Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-based Models to Assess Natural Defenses in the Northeastern USA. . Lloyd's Tercentenary Research Foundation.
- Bishop, Joshua, William Evison, and Olivia White. 2010. TEEB for Business. . The Economics of Ecosystems and biodiversity.
- Bogner, A. B. Litting, and W. Menz. 2009. Interviewing Experts. . Research Methods Series (ECPR).
- Bonfield, Peter. 2016. The property flood resilience action plan - An action plan to enable better uptake of resilience measures for properties at high flood risk. . Department for Environment Flood & Rural Affairs.
- Botzen, W.J.W, and Van der J.C.J.M Bergh. 2008. Insurance Against Climate Change and Flooding in the Netherlands: Present, Future, and Comparison with Other Countries. Risk Analysis, Vol. 28, No. 2.
- Boulle, Bridget, Camille Frandon-Martinez, Jimmy Pitt-Watson, Tess Olsen-Rong, Alan Meng, and P. Candace. 2016. Bonds and climate change - The state of the market in 2016. . Climate Bonds Initiative and HSBC.
- Brady, Ivan, Gaile Cannella, Julianne Cheek, Michelle Fine, Uwe Flick, Mirka Koro-Ljungberg, Maggie MacLure, Janice Morse, Frederick Nafukho, Paula Saukko, Barbara Tedlock, and Harry Torrance. 2017. The Sage handbook of qualitative research. (Norman K. Denzin and Yvonna S. Lincoln, Eds.). . Sage.
- British Insurers, Association of. 2016. ABI Guide to Resistant and Resilient Repair After A Flood. . Association of British Insurers.
- Brown, C., B. Reyers, L. Ingwall-King, A. Mapendembe, J. Nel, P. O'Farrell, M. Dixon, and N. J. Bowles-Newark. 2014. Measuring Ecosystem Services - Guidance on developing ecosystem service indicators. . UNEP-WCMC, Cambridge, UK.
- Cohen-Shacham, E., G. Walters, C. Janzen, and Maginnis S. 2016. Nature-based Solutions to address global societal challenges. . IUCN.



- Cohn, Carolyn. 2017. Mangroves, coral reefs could cut flood insurance premiums: Lloyd's. Reuters.
- Colgan, C. S., M. W. Beck, and S. Narayan. 2017. Financing Natural Infrastructure for Coastal Flood Damage Reduction. . Lloyd's Tercentenary Research Foundation.
- Costanza, Robert., Stephen C. Farber, and Judith. Maxwell. 1989. Valuation and management of wetland ecosystems. Ecological Economics.
- De Groeve, Tom, K. Poljansek, Daniele Ehrlich, and Christina Corbane. 2014. Current status and Best Practices for Disaster Loss Data recording in EU Member States. . JRC Scientific and Policy Reports.
- Dow, S. Re, Shell, Unilever, and T. N. Conservancy. 2013. The Case for Green Infrastructure - Joint-Industry White Paper. . Dow, Swiss Re, Shell, Unilever, The Nature Conservancy.
- Dr. Hlatky, Thomas. (n.d.). NatCatInsurance and riskmanagement in a changing climate.
- Dr. Marescot, Laurent. 2013. Gestion résiliente du risque : un nouveau paradigme pour la modélisation des catastrophes. Les Innovations face au développement des catastrophes non-vie Journée d'études IARD Tours.
- Edesess, Michael. 2014. Catastrophe Bonds: An Important New Financial Instrument. . EDHEC-Risk Institute.
- Environment, F. Department for, and Rural Affairs. 2011. Flood risk and insurance: A roadmap to 2013 and beyond - Final report of the flood insurance working groups. . DEFRA.
- Environment Food, D. for, and R. Affairs. 2007. An introductory guide to valuing ecosystem services. . Department for Environment, Food and Rural Affairs.
- European Commission. 2013. Greenpaper on the insurance of natural and man-made disasters. . European Commission.
- European Commission. 2015. Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. . European Commission,.
- Farina, Maria-Bianca. (n.d.). Cosa fanno le assicurazioni per prevenire i rischi e proteggere i cittadini?
- Flotow, Dr Paschen von, and Dr Lutz Cleemann. 2009. Jointly Developing Climate Information Systems: Requirements for the Climate Service Center (CSC) from the perspective of the financial sector. . Climate Change Financial Markets and Innovation.
- Francis, Angela, Sue Armstrong Brown, A. William Tipper, and Nickl Wheeler. 2016. New markets for land and nature How Natural Infrastructure Schemes could pay for a better environment. . Green Alliance & National Trust.
- German Insurance Association. 2013. Position Paper of the German Insurance Association on the consultation on the Green Paper on the Insurance of Natural and Man-Made Disasters. . German Insurance Association.
- Gizzi, Fabrizio Terenzio, Maria Rosaria Potenza, and Cinzia Zotta. 2016. The Insurance Market of Natural Hazards for Residential Properties in Italy. Open Journal of Earthquake Research.



- Golnaraghi, Maryam Ian Branagan Stuart Fraser Jonathon Gascoigne, and A. M. Gordon. 2017. Guidelines for Risk Assessment to Support Sovereign Risk Financing and Risk Transfer. . The Geneva Association and Insurance Development Forum.
- Gorvett, Rick. 2014. Actuaries and Climate Change: Insights from Economic Theory. Casualty Actuarial Society E-Forum.
- Green, Tom L., Jakub Kronenberg, Erik Andersson, T. Elmqvist, and and Erik Gomez-Baggethun. 2016. Insurance Value of Green Infrastructure in and Around Cities. Ecosystems.
- Group, A., and T. U. F. P. for Sustainable Insurance Initiative. 2015. Business Unusual: Why the climate is changing the rules for our cities and SMEs. . AXA Group and The UNEP FI Principles for Sustainable Insurance Initiative.
- Hagenlocher, Michael, Matthias Garschagen, Lena Klockleemann, Manuel Holzhauer, and Astrid Zwick. 2017. Disaster risk and readiness for insurance solutions, a novel assessment tool for low to lower middle income countries (InsuRisk Assessment Tool). . United Nations University,.
- Holling., C.S. 1986. Sustainable development of the biosphere. Pages 292–320 in W. Clark. and R. Munn., editors. Cambridge University Press.
- Honegger, Caspar, K. Schoeck, and Valentina Ghiani. 2016. Flood resilience in Italy Acting together. . Swiss Re.
- Hudson, Paul. 2015. Implication of risk based insurance premiums for flood preparedness and affordability of coverage. Thematic Session: automatic and planned adaptation to climate change European Association of Environmental and Resource Economists 21st Annual Conference. . Helsinki, Finland.
- IEEP, R. Energy, Environment, ClimateKos, and Trinomics. 2017. Climate mainstreaming in the EU Budget: preparing for the next MFF. . European Commission,.
- Insurance Europe. 2016. European Insurance Figures - 2015 data. . Insurance Europe.
- International Finance Corporation. 2016. Innovative insurance to manage climate risks. . IFC.
- IPCC. 2014a. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Page 688 (B. et al., Ed.). . Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC. 2014b. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Page 1132 (R. K. P. Core Writing Team and L. A. Meyer, Eds.). . Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Kabisch, N. N. Frantzeskaki S. Pauleit S. Naumann M. Davis M. Artmann D. Haase S. Knapp H. Korn J. Stadler K. Zaunberger, and A. Bonn. 2017. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. . Ecology and Society.
- Kirbyshire, Amy, Emma Lovell, Rebecca Nadin, Erin Roberts, Thomas Tanner, and Lena Weingärtner. 2017. A review of literature, debates and blogs on resilience,. . ODI,.



- l'économie, Service de de l'évaluation et de l'intégration du développement durable. 2010. Le régime d'assurance des catastrophes naturelles en France métropolitaine entre 1995 et 2006. . Commissariat général au développement durable.
- Laforest, J. 2009. Guide to organizing semi-structured interviews with key informant. . Institut national de santé publique.
- Le Den, Xavier Matilda Persson Audrey Benoist Paul Hudson De Ruiter Marieen Laars De Ruig, and O. Kuik. 2017. Insurance of weather and climate-related disaster risk: Inventory and analysis of mechanisms to support damage prevention in the EU. . European Commission.
- Lovink, J. S., Mathis Wackernagel, and Steven H. Goldfinger. 2004. Eco-Insurance: Risk Management for the 21st Century - Towards a policy framework for sustainable future. The Hague Conference on Environment, Security and Sustainable Development. . The Hague Conference on Environment, Security and Sustainable Development.
- Maccaferri, S., F. Cariboni, and F. Campolongo. 2012. Natural Catastrophes: Risk relevance and Insurance Coverage in the EU. . Institute for the Protection and Security of the Citizen.
- Maynard, T. 2017. Future Cities: Building infrastructure resilience. . Lloyd's of London.
- Michell, Nick. 2016. The new role of insurers in resilience planning. Pages 26–30 in Jonathan Andrews, editor. Cities Today.
- Mills, E. 2013. Insurers as Partners in Inclusive Green Growth. . World Bank.
- Munich Re. 2017. Natural catastrophes 2016 Analyses, assessments, positions, 2017 issue. . Munich Re - Topics Geo.
- Murti, Radhika, and Camille Buyck. 2014. Safe Havens, Protected Areas for Disaster Risk Reduction and Climate Change Adaptation. . IUCN,.
- Mysiak, Jaroslav, and Swenja Surminski. 2013. ENHANCE Consortium's response to Green paper on the insurance of natural and man-made disasters (COM(2013) 213 final). . Enhance.
- Narayan, S., M. W. Beck, B. G. Reguero, I. J. Losada, B. van Wesenbeeck, N. Pontee, J. N. Sanchirico, J. C. Ingram, G. M. Lange, and K. A. Burks-Copes. 2016. The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. PLoS ONE 11(5).
- Narayan, S., Paul Wilson, Christopher J. Thomas, Alexandra Guerrero, Christine C. Shepard, Borja G. Reguero, Guillermo Franco, J. C. Ingram, and D. Trespalacios. 2017. The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports.
- National Flood Insurance Program. 2015. Community Rating System, a local official's guide to saving lives, preventing property damage and reducing the cost of flood insurance. . Federal Emergency Management Agency.
- Network, S., G. Parametrics, and Humanitarian Innovation Fund. 2017. Drought Financing Facility. . Start Network and Global Parametrics and Humanitarian Innovation Fund.
- OECD. 2015. Private Disaster Risk Financing Tools and Markets And The Need for Financial Preparedness. . OECD,.
- OECD. 2017. Recommendation on Disaster Risk Financing Strategies. . OECD.



- Oppla. 2017. Oppla Insight Event, nature-based solutions: opportunities for business. . Oppla, P, D. D. L. 2017. Législation comparée, les systèmes d'indemnisation des catastrophes naturelles. . Sénat.
- Pascual, U., R. Muradian, L. Brander, E. Gómez-Baggethun, B. Martín-López, M. Verma, P. Armsworth, M. Christie, H. Cornelissen, F. Eppink, J. Farley, J. Loomis, L. Pearson, C. Perrings, and S. Polasky. 2010. Chapter 5 - The economics of valuing ecosystem services and biodiversity. . The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations.
- Paudel, Youbaraj. 2012. A Comparative Study of Public—Private Catastrophe Insurance Systems: Lessons from Current Practices. The Geneva Papers.
- Peara, A., and E. Mills. 1999. Climate for Change - An Actuarial Perspective on Global Warming and its Potential Impact on Insurers. Pages 16–23 in C. J. of the American Academy of Actuaries, editor. Contingencies: Journal of the American Academy of Actuaries, pp. 16-23. . Contingencies: Journal of the American Academy of Actuaries.
- Pearce, D. 2000. The insurance industry and the conservation of biological diversity: an analysis of the prospects for market creation. . University College London and OECD.
- Pimbert, François. 2014. Introduction aux modèles catastrophes, une solution pour estimer les accumulations inondations. Aon Benfield Canada ULC - Proprietary & Confidential.
- Porrini, Donatella, and Reimund Schwarze. 2011. Defining insurance models within climate change european policies. Research Papers Issue.
- Program, N. F. I. 2016. Community Rating System. . National Flood Insurance Program.
- Raadgever, T., Martijn Steenstra, J. Steenbergen, Marlous Van Herten, Dries Hegger, M. Bakker, and C. Dieperink. 2014. Towards improving the implementation of integrated flood risk management. Policy brief. . Policy Brief.
- Réassurance, Caisse Centrale de. 2015. Modélisation de l'impact du changement climatique sur les dommages assurés dans le cadre du régime Catastrophes Naturelles. . Caisse Centrale de Réassurance.
- Renaud, Fabrice, Karen Sudmeier-Rieux, and Marisol Estrella. 2013. The Role of Ecosystems in Disaster Risk Reduction. (Fabrice Renaud, Karen Sudmeier-Rieux, and Marisol Estrella, Eds.). . UNU-Press Editor.
- Rentschler, Jun, and T. Tanner. 2015. Unlocking the "Triple Dividend" of Resilience" Why investing in disaster risk management pays off. . Overseas Development Institute (ODI), International Bank for Reconstruction and Development, International Development Association or The World Bank.
- Richards, L. 2005. Handling qualitative data, a practical guide. (L. Richards, Ed.). . Sage.
- Risk Management Solutions. 2017. Mapping the role of insurance in managing disaster losses - A study of low and low-middle income countries. . RMS.
- Saldana, J. 2016. The coding manual for qualitative researches. (J. Seaman, Ed.). . Companion website, Sage.



- Schäfer, Laura, Sönke Kreft, Eleanor Waters, and Michael Zissener. 2016. Making climate risk insurance work for the most vulnerable: seven guiding principles. . Munich Climate Insurance Initiative.
- Schwarze, R. 2012. Insurance Law and Economics Research for Natural Hazard Management in a Changing Climate. The Geneva Papers on Risk and Insurance - Issues and Practice 37:201–205.
- Silvis, H. J., and C. M. van der Heide. 2013. Economic viewpoints on ecosystem services. . WOt Reports (Wettelijke Onderzoekstaken Natuur & Milieu).
- Slovenia Insurance Association. 2016. Statistical Insurance Bulletin 2016. . Slovenia Insurance Association.
- Sousounis, Peter J., and Little Christopher M. 2017. Climate change impacts on extreme weather. . Air Worldwide.
- Stephens, Tim. 2017. Coastal wetlands dramatically reduce property losses during hurricanes. Newscenter.
- Stern, Nicholas. 2006. Stern Review: The Economics of Climate change. . World Bank, OECD, EBRD, IADB, and UNEP (IPCC),.
- Sudmeier-Rieux, Karen. 2013. Ecosystem approach to disaster risk reduction - Basic concepts and recommendations to governments, with a special focus on Europe. . European and Mediterranean Major Hazards Agreement (EUR-OPA).
- Sudmeier-Rieux, Karen, Neville Ash, and Radhika Murti. 2013. Environmental Guidance Note for Disaster Risk Reduction. . IUCN.
- Surminski, S., J. Aerts, Wouter Botzen, Paul Hudson, Jaroslav Mysiak, and Pérez-Blanco. 2015. Reflections on the current debate on how to link flood insurance and disaster risk reduction in the European Union. Natural Hazards.
- Surminski, S., and Diana Kool. 2016. Taking a risk on the weather. Pages 49–53 in F. World, editor. Financial World. . Financial World.
- Surminski, Swenja, Laurens M. Bouwer, and Joanne Linnerooth-Bayer. 2016. How insurance can support climate resilience? Nature Climate Change.
- Susanne, H. L.-B. Joanne S. Swenja N.-P. Cristina L. Anna I. Radu, and Patt Anthony. 2017. Insurance, Public Assistance, and Household Flood Risk Reduction: A Comparative Study of Austria, England, and Romania. . Risk Analysis.
- Sustainability Leadership (CISL), University of Cambridge Institute for. 2016. Investing for Resilience. . Cambridge, UK: Cambridge Institute for Sustainability Leadership.
- Suykens, C., Priest S. J., W. J. Van Doorn-Hoekveld, T. Thuillier, and M. Van Rijswijk. 2016. Dealing with flood damages: will prevention, mitigation, and ex post compensation provide for a resilient triangle? Ecology and Society 21.
- Swiss Re. 2017. News release. . Swiss Re,.
- Tanner, Thomas, Swenja Surminski, Emily Wilkinson, Robert Reid, Jun Rentschler, and Sumati Rajput. 2015. The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. . Global Facility for Disaster



- Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI).
- Team, C. W., Rajendra K. Pachauri, and Leo Meyer. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. . IPCC.
- Thistlethwaite, Jason, and Andrea Minano. 2016. Managing Climate Change Risk In Coastal Canadian Communities through Sustainable Insurance. Policy Brief No. 93. . Policy Brief.
- Tipper, A. William, and A. Francis. 2017. Natural Infrastructure Schemes in practice How to create new markets for ecosystem services from land. . Green Alliance and National Trust.
- Tomas, Julien. 2014. Gestion des risques naturels et changement climatique: les challenges des actuaires. Pages 5–105 (Julien Tomas, Ed.) Bulletin Français d’Actuariat, Vol. 14, n° 28, pp. 5-105. . Institut des Actuaires.
- Triglav Group. 2017. 2016 Results Presentation. . Triglav Group.
- UNEP. 2016. Report of the Italian National Dialogue on Sustainable Finance. . UNEP, .
- UNEP Finance Initiative. 2015. The PSI Global Resilience Project - Collaborating of resilience - Partnerships that build disaster-resilient communities and economies. . United Nations Environment Programme.
- United Nations Framework Convention On Climate Change. 2015. Paris Agreement - COP21. . UNFCCC.
- Veyret, Y., G. Garry, and N. M. de Richemond. 2004. Risques naturels et aménagements en Europe : répartition des compétences, niveaux territoriaux de gestion des risques et acteurs (Natural risks and development control in Europe : institutional structures, steps for risks management and actors). Bulletin de l’Association de géographes français 81:103–113.
- Walker, B. H. 1992. Biodiversity and Ecological Redundancy. Conservation Biology 6:18–23.
- Warner, K. Ranger Nicola Surminski Swenja Arnold Margaret Linnnerooth-Bayer Joanne Michel-Kerjan Erwann Paul; Kovacs, and C. Herweijer. 2009. Adaptation to Climate Change: Linking Disaster Risk Reduction and Insurance. . UNIDSR.
- WBCSD. 2017. Incentives for natural infrastructure, review of existing policies, incentives and barriers related to permitting, finance and insurance of natural infrastructure. . WBCSD.



9. Appendixes

9.1 Appendix 1 : Full questionnaire

Section 1 Risk-assessment related with natural hazards

1. Have you made a risk assessment of your networks and key assets/Demo/Region?
Which assets are more at risk?
2. What are the main natural hazards you perceive as risks for your country/Demo/Asset?
3. Are Climate-driven extreme events one of them?
4. If so, how: do you integrate climate change scenarios in risk evaluation? How is the climate change included in your models? How do you generate climate scenarios?
5. What are the physical parameters describing risk at your country/Demo/Asset? (e.g., wind speed, water level, etc.)
6. How do you cope with (often imperfect) information and knowledge? How uncertainties are taken into account?
7. Is the information/data available to everyone? Where people can find data and other information on natural risks? Can this information help people to have a better understanding of the risk?
8. Who are your peers? How do you seek advices?
9. Who carries the risks of extreme events? You or your (public) client?

Section 2 The role of the protective measures against natural hazards

1. How do you manage the risks (list mentioned above) under your responsibility? We would value concrete examples.
 - a) Taking prevention measures: risk mitigation- risk reduction measures, structural measures, if so, which?
 - b) Preparedness and Crisis Management protocols?
 - c) Insurance/ transferring the residual risk or pooling/compensation.
2. How risks are managed along the project cycle of infrastructure investments (where water management is relevant) and how these risks are shared with the private sector?
Give an indication of:
 - a) Which sector – public or private- is responsible for managing these risks and therefore willing to invest in DRR measures?
 - b) Gaps within the investment system that need to be solved with DRR and system understanding expertise.
3. Who maintains and operates protective (Mitigation/adaptation) structures? How are they funded? Who carries the risk of failure?
4. Are insurance contracts available for those protective structures, or are they considered in insurance contracts?



Section 3 Development of a new European legal framework for implementation of the

IVE

1. Does the current European legal and market framework permit to harmonize insurance premiums at the EU level? (Develop and discuss your opinion)
2. What are the main differences between legal and market frameworks in each country?
3. Is it possible to create a regional risk-pooling scheme at the EU level? (Develop and discuss your opinion)
4. How are climate risks assigned, for different economic sectors, by European insurance companies? Are these policies under any degree of reconsideration?

Section 4 (re)insurance framework descriptions

1. Can the insurer refuse to cover a property because of the future expected natural hazard (in your country)? Does everybody have access to insurances? If insurance coverage is not possible, what is done in this case?
2. How do you economically assess the indirect costs/effects of a disaster? (e.g., road/airport closure consequences; business interruption)
3. Which insurance options do you have for your key assets and per type of risk?

Could you give us an impression of the comparative size of insurance premiums you pay for natural hazard risks, versus other risks as safety of employers, fires, burglary, etc?

How are these insurance policies aggregated? (Which subcategories are there and their relative size)

4. How do you evaluate your own insurance system?

Section 5 Economic issues related to insurances

1. What is the basic knowledge for premiums calculation and how are they calculated?
2. Could your insurance company create financial incentives (e.g., premium reduction) for policyholders who have implemented prevention/mitigation measures and what is provided to whom they have not implemented that before any (flooding) natural hazard?
3. Are risk reduction measures considered to modify premiums? If yes, which type of measures are they? Please rank these different resilient measures based on which criterion?

Section 6 Risk awareness risk perception: current knowledge and gaps

1. Does the insurance industry have mechanisms in practice or under development to deal with variance in perception of risk?



2. How far the member state's risk culture aspects have to be considered by your insurance company in your proposal of risk mitigation measures? What are the main risk culture differences in the EU countries?
3. How would you most likely communicate with your customer about flood/droughts/other climate related hazard resilience? (e.g., standards for reconstruction of their houses, etc.)
4. How has your risk perception changed with the climate change? (brokers: about the perception of their clients)



Sections 7 Linkages between the insurance sector and NBS, ecosystems

1. What are the new challenges for your insurance company to cope with climate-related risks?
2. What are tangible examples of projects to address existing or potential climate risks your organization has pursued?
3. What is the insurance company conceptual understanding of ecosystem-based disaster risk reduction?
4. What is the insurance company conceptual understanding of insurance value of ecosystem?
5. What is your current knowledge of positive or negative effects of ecosystems?
6. Do you recognize any particular ecosystem as a defense or resilient measure to face natural hazards?
7. Is there any insurance contract for risks related to ecosystem effects? (e.g., wildfires, woody debris jamming on bridges, etc.)
8. Do you have a specific strategy to incorporate nature-based solution or insurance value of ecosystems in risk assessment strategies? (e.g., key green policies, monetary choices for integration into green solutions portfolios)
9. How your insurance company can develop models for calculating scenarios of risk reduction for different types of ecosystem services?
10. Which knowledge and tools would be required? Do you know of tools being developed? (Please list them)
11. How your insurance companies can/could develop methods to implement the concept of insurance value of ecosystem?
12. To what extent has the concept of nature-based solution been integrated in your policy framework? Are there pioneer examples around the world?
13. How could you do partnerships with insurance companies/clients? To design insurance schemes and NBS standards that strengthen and incentive DRR?
14. Tell us more about how could that work? (e.g. who pays what, required regulatory changes or economic instruments?) Have you seen such example elsewhere, in EU or outside Europe?
15. What do you know and think of Resilience/Green/Cat Bonds? Could they work to finance NBS? Under which conditions? Which other similar products in development you know of?
16. In addition to risk reduction role of ecosystems, can the environment preservation be an additional motivation for your insurance company? (e.g. for your image? if so, which options would have your preference?)
17. Do you ever finance risk reduction measures? As “insurance” company? And/or as institutional investor? How do you separate these two roles?



A) If you do invest as insurance company, would you be willing to finance Nature-Based Solutions for DRR? Why?

B) And as Institutional Investor? If you are investing, could you give us examples? If not, specify the reasons and/or bottlenecks?

18. Do you ever reimburse risk reduction investments made by your clients?

As it is for example done in Health insurance policies that covers up to a certain amount the costs of a gym subscription? Are there plans to do so in this field?

19. What can be the minimal amount of your (re)insurance companies' investments, that will be required to fund those measures? How much of loss can your (re)insurance companies avert, with investments in what grey, green/blue, hybrid measures? (calculating benefit/investment ratios)

20. How do your models take into account the green/NBS options for DRR taken by your client? Why?

21. Concerning the barriers in hindering the uptake of nature-based solutions in practice into insurance policies: How important are the following barriers? Could you give please concrete examples per category.

Natural (physical barriers)

Social (social validation)

Human (cultural)

Financial

Legal

Section 8 Funding DRR measures and ecosystem services

1. What are the most important sources of Funding for Disaster Risk Reduction Measures? Taxes, Tariffs or Transfer? (Explain more in detail) and who collects them and is responsible for their budgeting? And procurement?
2. Are there any additional important sources of funds (e.g. Structural funds) and/or strategic partners for the implementation, funding and/or financing of DRR measures? - and for NBS specifically?
3. Are Public-Private Partnerships contracts being used for the procurement of DRR measures? If so, could you give us examples?
4. Which innovative Green/Climate finance (Urban and Rural NBS, Watershed conservation, Natural Foreshores) Funding strategies, financing mechanisms and innovative business models have been applied in your country?
We would value concrete examples and/or contact persons.
5. Which economic and regulatory instruments do you consider key in incentivizing private sector and society to opt for NBS- for Resilience and Water Security?



6. Do you think a new model would be needed to consider NBS or should we only adapt the current scheme?
7. Do you think a preliminary marketing survey would be needed to check that a market really exists? (a real demand from possible customers)
8. Do you think using NBS could provide a competitive advantage for your company?
9. Do you think those new business models could be created by companies or should it be imposed by European regulations?



9.2 Appendix 2: The Grounded Theory

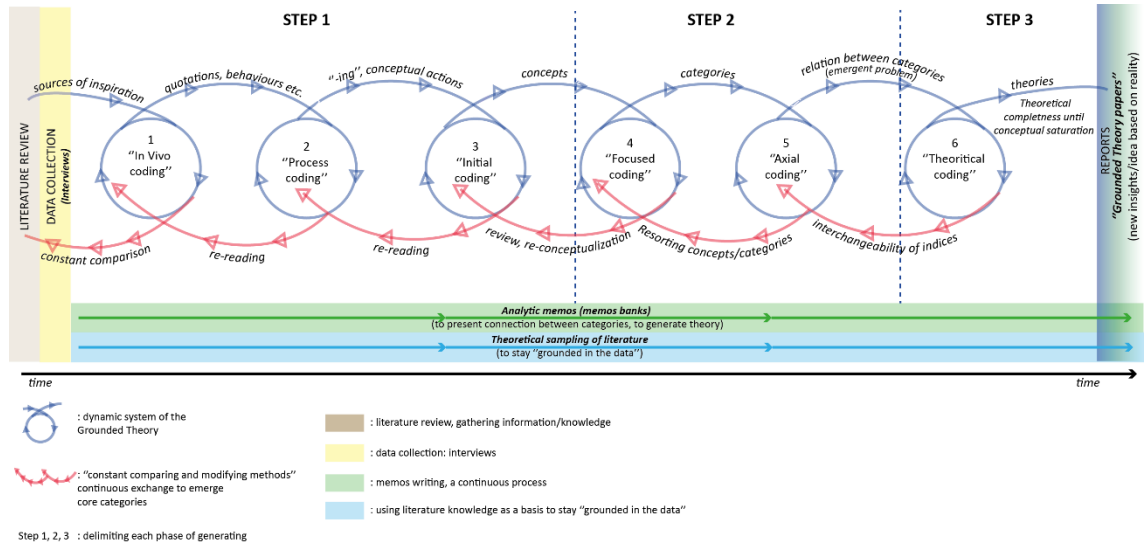


Figure 25: Graphic representation of Grounded Theory's steps (References: Marchal R., IRSTEA, 2017)

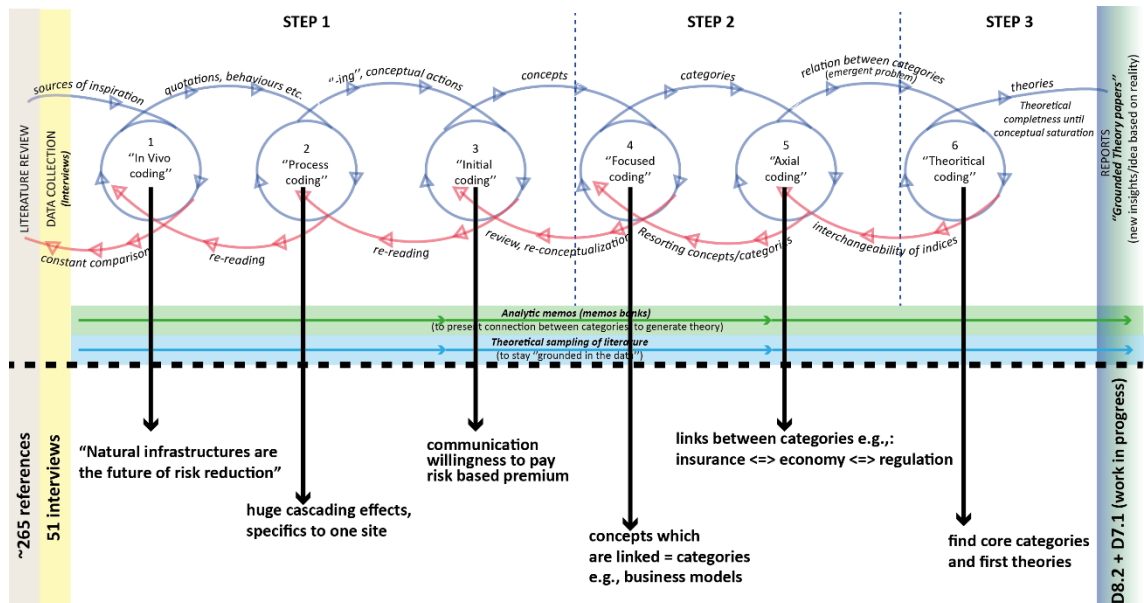


Figure 26: Practical example to apply Grounded Theory's steps, (References: Marchal R., IRSTEA, 2017)



9.3 Appendix 3: Database Interview structure

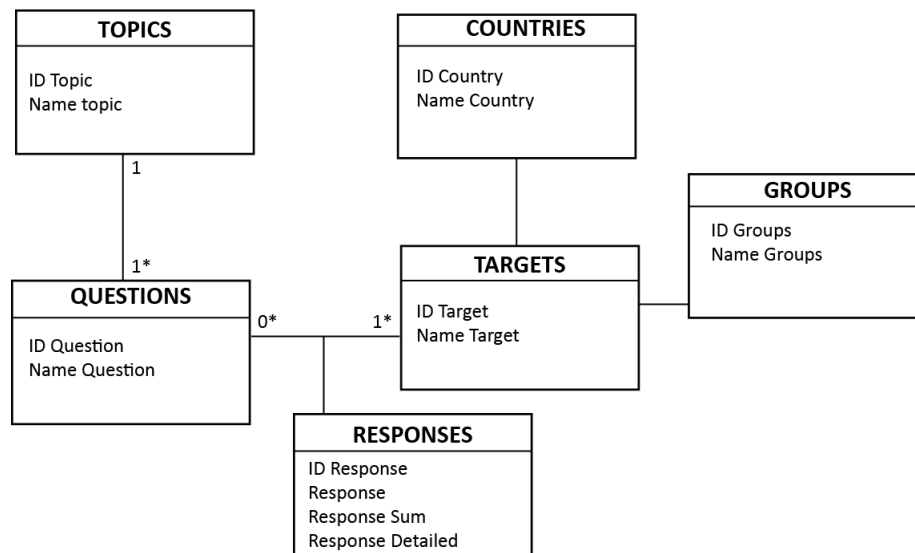


Figure 27 : One unique database to facilitate data analysis (References: Marchal R., IRSTEA, 2017)

9.4 Appendix 4: Classification of European insurance system

This classification is based on the (Porrini and Schwarze 2011) classifications, which proposed 5 classes to classify insurance system:

- M1, (regional) public monopoly insurance: Netherlands, Denmark, Switzerland
- M2, compulsory insurance of all-natural hazards: Netherlands, Denmark, Switzerland, France (except windstorm, hail and snow), Spain
- M3, compulsory inclusion of all-natural hazards into general house owner insurance: France, Spain, Great Britain
- M4, free market insurance with ad-hoc governmental relief programs: Germany, Austria, Italy
- M5, tax-financed governmental disaster funds: Austria, Italy

By analysing these different clusters, the same country can be into two different classes and not all European member states are classified.

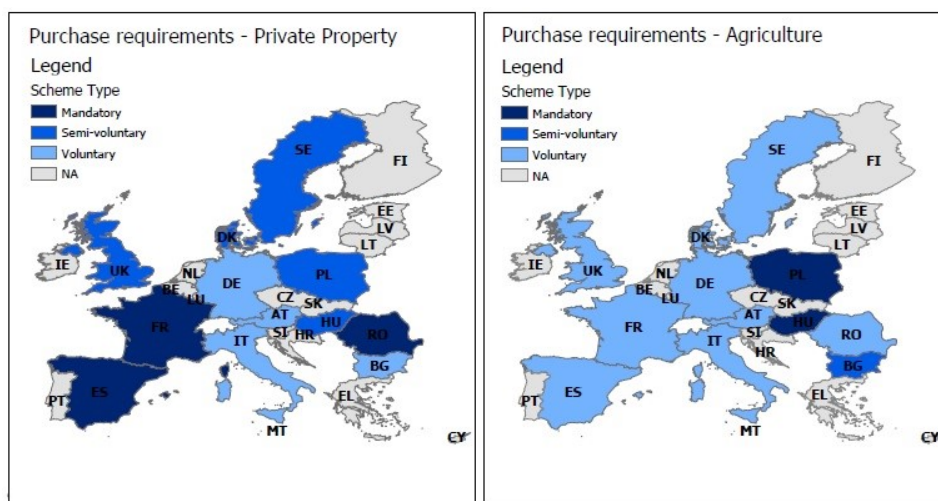


Figure 28 : The three main market classifications (Reference: (Le Den and Kuik 2017 p. 50)

The average insurance penetration in Europe is 7.41% in 2015 (Insurance Europe 2016). Spain, France, UK and Sweden have high penetration rates (~80%) due to the mandatory scheme or because insurance coverage is a mandatory mortgage requirement (Figure 29).

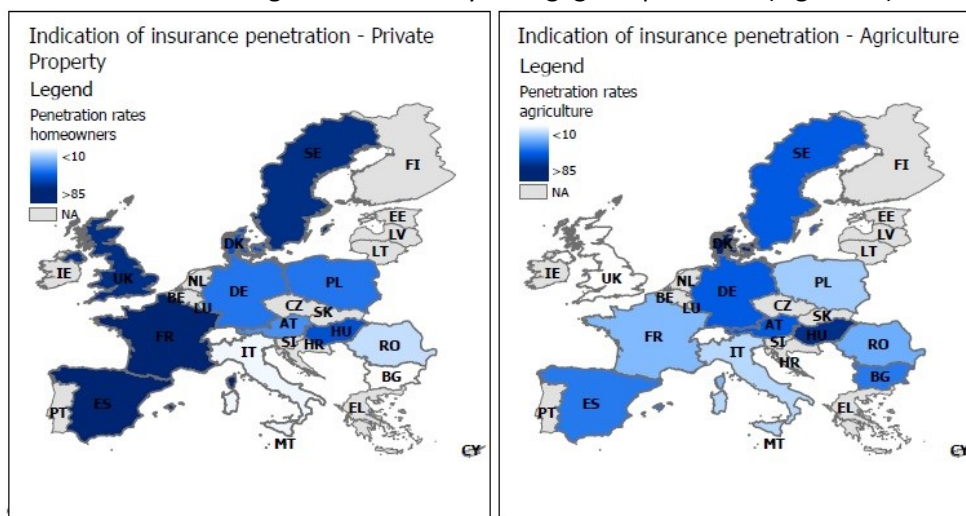


Figure 29: Indication of insurance penetration, (Reference: (Le Den and Kuik 2017 p. 51)

Independently of the insurance market scheme (voluntary or mandatory), there are two premium setting rules: risk-based premium (influencing behaviour) or flat-rate (increase social solidarity). Risk-based premiums often consider risk prevention measures and exposure (Germany, Austria), only four European countries employ such premiums, other countries employ flat rate premiums (no risk differentiation and where exposure is not taken into account) Figure 31.



“The risk-reduction incentives most systematically are policyholder deductibles” p52 (Figure 32), the deductibles are adjusted according to the recurrence of disasters (France, Denmark - Figure 30). In France, modulation of the deductibles is fixed by law and only in municipalities without Risk Prevention Plans (RPP), on the contrary, in Denmark, the amount of the deductible varies according to the amount of compensation, this percentage is fixed by the Danish Storm Council.

FRANCE
Modulation of deductibles in municipalities without RPP

		Modulation of the basic deductible	Policyholders €380	Businesses €1140
All risks	3rd declaration of disaster	x2	€760	€2280
	4th declaration of disaster	x3	€1140	€3420
	5th declaration of disaster	x4	€3040	€4560
Drought	3rd declaration of disaster	x2	€3040	€6100
	4th declaration of disaster	x3	€4560	€9150
	5th declaration of disaster	x4	€6080	€12200

DENMARK
Modulation of deductibles for all insured

		Policyholders Home	Policyholders Holiday home	Businesses
Storm surge	1st declaration of disaster	5%	10%	10%
	2nd declaration of disaster	10%	15%	15%
	3rd declaration of disaster	15% (min €~700)	20% (min €~1400)	20% (min €~1400)

Figure 30: France (mandatory insurance) and Denmark (voluntary insurance), two examples of modulation of the deductibles according to the recurrence of disasters (References: CCR & Danish Storm Council 2017).

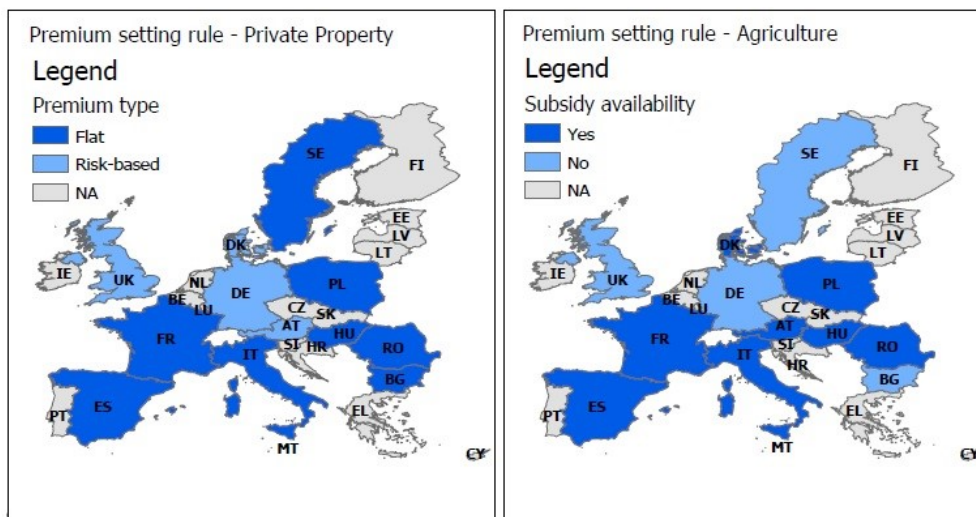




Figure 31: Premium setting rules (Reference: (Le Den and Kuik 2017 p. 52)

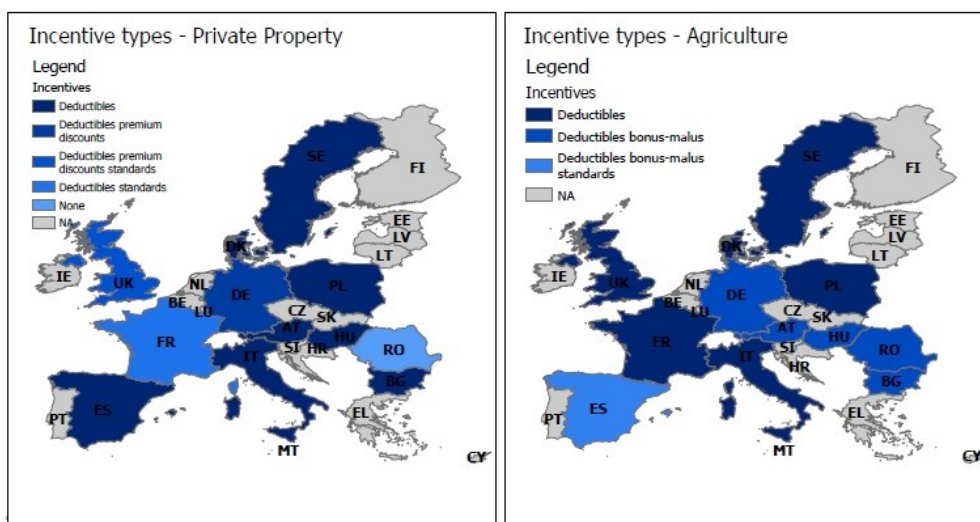


Figure 32 : Incentive types, often a deductible-based risk reduction (Reference: (Le Den and Kuik 2017 p. 53)

The ability to absorb large losses in the countries are based on: government as insurer of last resort, reinsurance, or ad-hoc funds, so-called specific pool (funding by levy on fire insurance policies, e.g. Denmark with the fund for storm surge/flood/windfall or UK with the fund for flood-risk households) or private reinsurance with an unlimited State guarantee (Spain, France ¡Error! No se encuentra el origen de la referencia., Figure 34).

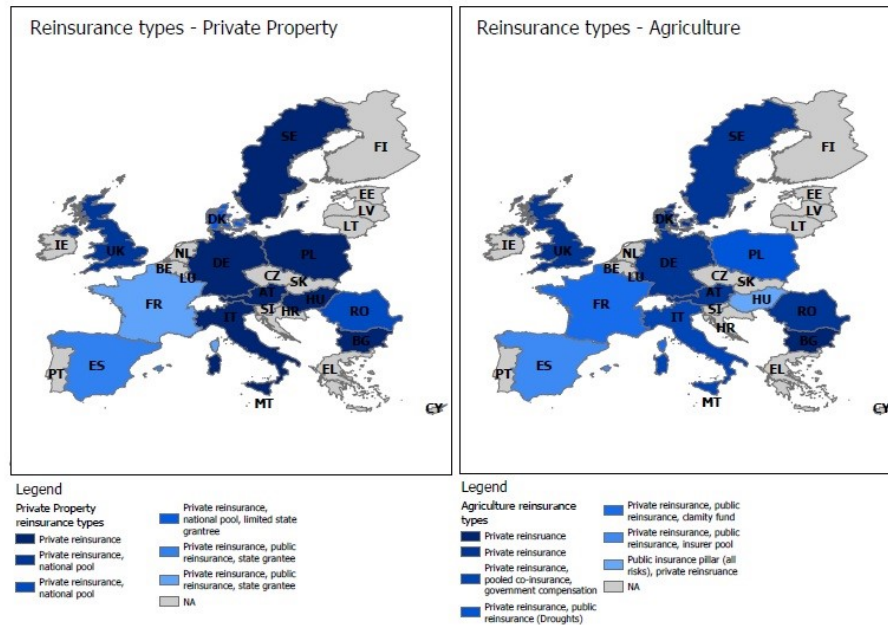


Figure 33 : Reinsurance types (References: (Le Den and Kuik 2017 p. 53)

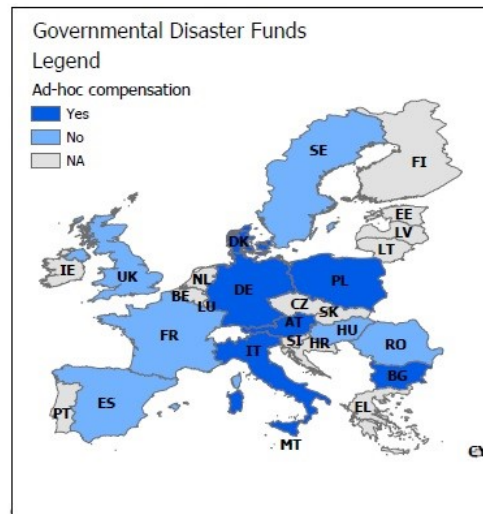


Figure 34 : Governmental disaster funds (ad-hoc or dedicated funds) (Reference: (Le Den and Kuik 2017 p. 53)

Another classification, not based on global natural catastrophe insurance, but based on cluster of Member States for flood, storm and earthquake insurance, is done by (Maccaferri et al. 2012).



Table 6: European flood insurance cluster (Reference: (Maccaferri et al. 2012))

Flood insurance – European clusters		
Cluster	Country	Features
1	Belgium, Ireland, France, Sweden and UK	Insurance market seems to have efficiently developed, as total losses (both historical and simulated) are not very high, while penetration rates are high; these MS NatCat insurance is bundled with another base policy, usually fire, households and damages insurances
2	Spain, Portugal	Insurance market seems to be rather adequate because both total losses and the potential impact of flood are low; rate of penetration is not that high
3	Denmark, Greece, Italy	Total losses and potential impact of flood when insurance in place is considered are low but flood insurance is sold on the market only as an optional extension of other policies; low penetration rate
4	Poland, Slovenia	Size of the NatCat is moderate according to both the historical data and the 99th percentile of the loss distribution; flood insurance is sold as an optional extension and the penetration rate is low
5	Bulgaria, Austria and Finland	Both total losses and potential impact of flood are moderate; flood insurance in Bulgaria and Austria is sold as an optional extension in basic homeowners' policies; low penetration rate
Undefined	Netherlands	special case because flood is uninsurable, but the government reimburses in case of need
Lack of data	Estonia, Cyprus, Lithuania, Hungary, Malta	//
Heterogenous Characteristics	Czech Republic, Denmark, Luxembourg, Romania, Slovakia	//

Table 7: European storm insurance cluster (Reference:(Maccaferri et al. 2012))

Storm insurance – European clusters		
Cluster	Country	Features
1	Belgium, Ireland, Austria, Finland, UK	Insurance market seems to have efficiently developed, as total losses (both historical and simulated) are not very high, while penetration rates are high; these MS storm insurance is bundled with another base policy, usually fire, households and damages insurances
2	France and Luxembourg	Risk is moderate and penetration rate is high; storm insurance bundled with another base policy
3	Czech Republic, Spain, Portugal	Insurance market seems to be adequate because total losses are low; storm insurance bundled with another base policies but low penetration rate
4	Denmark, Netherlands, Poland	Total losses not very high, penetration rates are high even if it is an optional extension of base policies
5	Denmark, Slovenia, and Sweden	Size of the risk is moderate, high penetration rate, optional extension of base policies
6	Bulgaria, Greece, Italy and Romania	Not relevant risk, low penetration rate



Table 8: European earthquake insurance cluster (Reference: (Maccaferri et al. 2012))

Earthquake insurance – European clusters		
Cluster	Country	Features
1	Belgium, Ireland, Spain, France and UK	Insurance market seems to have efficiently developed, as total losses (both historical) are not very high, while penetration rates are high; these MS NATatCat insurance is bundled with another base policy, usually fire, life and property insurances
2	Denmark and Slovenia	Risk is low, medium penetration rate; optional extension
3	Bulgaria, Austria, Portugal and Romania	Low penetration rate, earthquake insurance is not bundled to any base policy
4	Greece and Italy	Relevant impact, risk but penetration rate is low - extension of fire insurance
Undefined	Netherlands	Special case because earthquake is not insurable but the government reimburses in case of need

These two different classifications are not based on the same field, one side (the first) is based on global insurance system operation and the other side (the second), is based on risk level, penetration rate and insurance market (Table 6, Table 7 and

Table 8).

Other authors (Veyret et al. 2004, l'économie 2010, Paudel 2012, Raadgever et al. 2014, Bacani et al. 2015, OECD 2015, Gizzi et al. 2016, Insurance Europe 2016, Suykens et al. 2016) gathered information on differences between each Member State insurance system – not classifications. There is a significant diversity of existing natural catastrophe insurance schemes with different wordings, terms, conditions, definitions of natural hazards, claim managements and public disaster relief.



9.5 Appendix 5: The NFIP Program

The National Flood Insurance Program (United-States of America), Community Rating System: a way to link prevention measures and premium discounts.

The participation of communities, in the Community Rating System (CRS) is voluntary and free, it is the community's chief executive officer who handle the application work. In exchange, these communities will receive reduced flood insurance premiums and obtain a floodproofing certificate. The flood insurance premiums reflect the reduced flood risk. The procedure is typically the following:

First, to be eligible for a CRS discount, the community must do the Activity 310 "Elevation Certificates" – respected the certificates for new construction⁵⁷. A designated repetitive loss community must also do the Activity 510 "Floodplain management planning" – adopted and implemented "*a comprehensive flood hazard mitigation plan*". All other activities are optional to be eligible. If the community is not in conformity with the requirements of the NFIP, the latter imposed to the community a probation period, which increase the insurance premium (National Flood Insurance Program 2015). On the other hand, the CRS discount is not eligible for "Emergency Program" Communities, PRP, Newly Mapped Rates Policies, Mortgage Portfolio Protection Program Policies and Group Flood Insurance Policies. Flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions. FEMA makes available NFIP flood insurance to homeowners, renters, business owners within this community. The community must have implemented flood proofing "*any combination of*

How much discount property owners in your community can get

Rate Class	Discount		Credit Points Required
	SFHA*	Non-SFHA**	
1	45%	10%	4,500 +
2	40%	10%	4,000 - 4,499
3	35%	10%	3,500 - 3,999
4	30%	10%	3,000 - 3,499
5	25%	10%	2,500 - 2,999
6	20%	10%	2,000 - 2,499
7	15%	5%	1,500 - 1,999
8	10%	5%	1,000 - 1,499
9	5%	5%	500 - 999
10	0%	0%	0 - 499

Figure 35: Credit point required to reach given protection classes and the related possible discount (National Flood Insurance Program 2015 p. 3)

protection information, gives a maximum of 125 points (Program 2016 pp. 4–5). After applying those activities, the FEMA organizes verification visits to check the well-implementation of those measures and report the points. The CRS assigns the community to one of the ten classes

structural and non-structural additions, changes, adjustments to structures, which reduce or eliminate risk of flood damage" (Program 2016 p. 40). CRS provides for the community a list of 19 to-do-activities to get credits. These activities are classified into 4 categories: Public information, mapping and regulation, flood damage reduction and flood preparedness. Each activity gets credit, as an example the elevation certificates, gives a maximum of 116 points, flood

⁵⁷ The lowest floor of a business is compared to the Base Flood Elevation. The higher that lowest floor is above the base flood elevation, the more reduced the risk of flood damage and thus, the lower the premium.



according to the points (Figure 35). The community's discount on flood insurance premiums is based on this class. If the community earns 4.500 points or more (Class 1), property owners in the floodplain get a 45% discount on their premiums, while a Class 9 community would receive a 5% discount (Program 2016 p. 3).

During John Oliver's video on "Floods⁵⁸", the latter highlights the aspects of this system. First, he insists on the "aberration of repetitive flooded houses" located "in the ocean" and which costs too many dollars for the NFIP. He gives one relevant example of a house flooded 40 times, valued at \$55.921 and the NFIP has spent \$428.379 in flood claims. Second, he demonstrates that NFIP's maps are false, floods areas are not well-located according to real risks. Third, he denounces that private insurance companies abuse this system, "the bigger is the disaster, the more they stand for profit".

9.6 Appendix 6: the Natural Infrastructure Scheme (NIS)

The NIS has been developed following the Brexit issue, the lack of availability of public finances and the climate change. To ensure a well-functioning of this scheme based on public/private contracts, three conditions are necessary (Figure 38) to unlock the three dividends which are (1) a new commercial revenue for landowners; (2) improvements in flood protection; (3) and improvements of the natural environment. The insurance sector is seen as a potential customer

of the NIS. (Francis et al. 2016, Tipper and Francis 2017) demonstrate that insurers would want to use this service because it reduces pay outs to customer to restore their flooded property. They highlight the differences between the costs of repairing and restoring a flooded home over 15 years, for one home £20.000-45.000 (e.g., for 50 houses £1.250.000 – business as usual - BAU) and the costs of their contribution into the NIS,

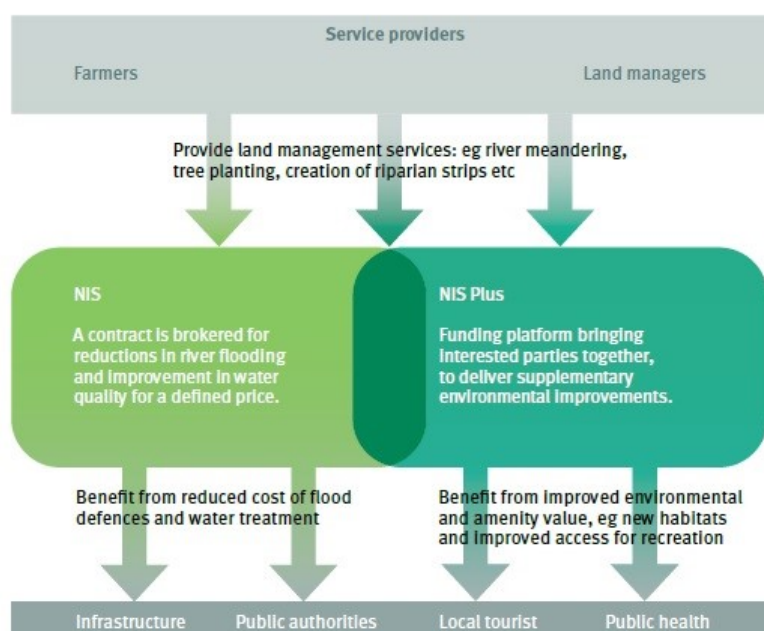


Figure 36 : How the Natural Infrastructure Scheme (NIS) could works? (source: (Francis et al. 2016 p. 3 and 27))

⁵⁸ John Oliver video "Floods", www.youtube.com/watch?v=pf1t7cs9dkc&app=desktop



£1.000.000. The financial saving pounds are £250.000 over 15 years. Globally, at the catchment scale, the two authors estimated that currently within the business as usual, the “buyers” spend £11.230.000. If they enter the NIS, the trading space for both sellers and buyers is £4.7 million, which is cheaper than the BAU (Figure 37). Their idea is to go further thanks to expertise and monitoring, by implementing independent assurance.

A new market is possible as Natural Infrastructure Scheme costs are lower



Figure 37: Comparison between current costs in the BAU and cost saving in the NIS
(Reference: (Tipper and Francis 2017 p. 3))

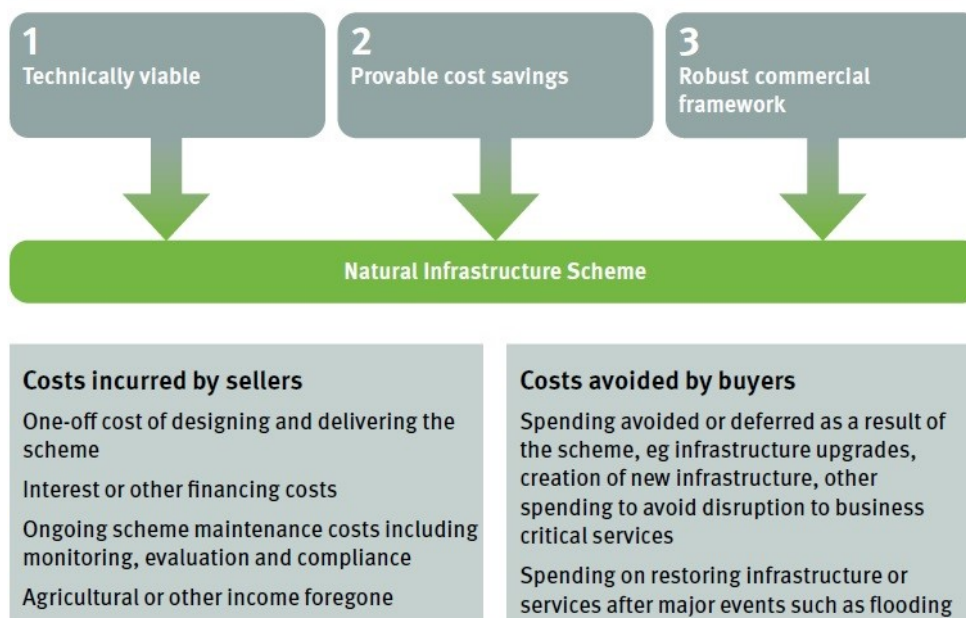


Figure 38 : Three conditions necessary to implement the NIS (Reference: (Tipper and Francis 2017 p. 7))



About the NAIAD project

'NAIAD' (Nature Insurance Value - Assessment and Demonstration) is an advanced, first of kind, EU Horizon 2020 applied research programme focused on Nature-Based Solutions (NBS) in risk management strategies, with a focus on water. NAIAD aims to operationalize the insurance value of ecosystems to reduce the human and economic cost of risks associated with water (floods and droughts) by developing and testing - with key insurers and municipalities - the concepts, tools, applications and instruments (business models) necessary for its mainstreaming.

This NAIAD report is based on a literature review and interviews with 61 people active in (re)insurance companies and related sectors in 11 European countries, performed in 2017.

This aim of the study was to offer new insights on the role the insurance industry could play to help address the goals of disaster risk reduction and adaptation to climate change, looking particularly at new opportunities around nature based solutions, both by comparing different insurance systems and by giving a global overview.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement No 730497.



The opinions expressed in this document reflect only the author's view and in no way reflect the European Commission's opinions. The European Commission is not responsible for any use that may be made of the information it contains.

Should you wish to use or refer to it, please cite as follows:

Marchal R., Piton G., Tacnet J-M., Zorrilla-Miras P., Lopez-Gunn E., Moncoulon D., Altamirano M., Matthews J., Joyce J., Nanu F., Groza I., Peña K., Dartée K., Pengal P., Cokan B., and van der Keur P., Burke S., Graveline N., (2017): "Milestone 4 - European survey on insurance systems and Natural Assurance Schemes (NAS)". EU Horizon 2020 NAIAD Project, Grant Agreement N°730497

Interested in more information?