

Chapter 3

Insurance and the Natural Assurance Value (of Ecosystems) in Risk Prevention and Reduction



Roxane Marchal, David Moncoulon, Elena López Gunn, Josh Weinberg, Kanika Thakar, Mónica Altamirano, and Guillaume Piton

Highlights

- The (re)insurance sector is found to play five roles in natural disasters loss prevention.
- The five roles lead to one objective: reducing exposure to risks using preventive measures.
- The impact of such roles could be fostered through partnerships.
- Further research is needed on the effectiveness of NBS on hazard reduction.
- Using challenging climate change to improve knowledge on natural disasters and NBS to ensure insurability of risks.

R. Marchal · D. Moncoulon
Caisse Centrale de Réassurance (CCR), Paris, France
e-mail: rmarchal@ccr.fr

E. López Gunn
ICATALIST S.L., Las Rozas, Madrid, Spain

J. Weinberg · K. Thakar
Stockholm International Water Institute (SIWI), Stockholm, Sweden

M. Altamirano
Deltares, Delft, The Netherlands

Faculty of Technology, Policy and Management, Delft University of Technology,
Delft, The Netherlands

G. Piton (✉)
Université Grenoble Alpes, INRAE, CNRS, IRD, Grenoble INP, IGE, Grenoble, France
e-mail: guillaume.piton@inrae.fr

3.1 Introduction

Flood events have huge impacts worldwide. In Europe, numerous examples can be found from the past decade that caused extensive damages (e.g., cloudburst in Copenhagen, Elbe floods in 2002, 2013, Danube floods in 2006, Alpes Maritimes floods in 2015, Lez floods in 2014, Seine floods in 2016 and 2018, etc.). Around 90% of natural hazards are water-related and these are likely to become more frequent and more severe as a result of climate change. Climate change is projected to increase damage up to 50% by 2050 in France (Moncoulon et al. 2018). Caisse Centrale de Réassurance (CCR) estimates that mean annual insured of flood hazards will be up to 38%, respectively 50% related to runoff hazard and 34% to river flooding.

Climate change is already resulting in rising levels of risk posed by natural disasters and the related costs these create (Lawrynuik 2019). The total reported losses caused by natural disasters over the period 1980–2014 reached approximately 453€ billion, with only 45% of these economic losses insured in Europe.¹ This is why the (re)insurance industry is a critical actor to engage and to understand its current and potential contributions to the assessment of the Natural Assurance Schemes (NAS) (Lopez-Gunn et al. 2022, Chap. 2 of this book).

The impact of climate change on the frequency and the intensity of natural hazards can create a myriad of challenges for the insurance industry's business model (Fédération Française de L'Assurance 2015a; Surminski and Kool 2016; Moncoulon et al. 2018). General insurers may face on the one hand, increasing physical risks which increases their underwriting liability and the number and costs of claims made and on the other hand, transition risks i.e. when there is increased market demand and high premiums could lead to limitations on coverage. Responding the climate change impacts by increasing premiums poses challenges to make both insurance and reinsurance coverage available and affordable. Higher premiums can make insurance coverage unaffordable and then lead to a greater protection gap i.e. when less people are covered by an insurance contract. Nowadays, the industry is slowly moving towards ex-ante actions (Cardone 2018; Marchal et al. 2019). It means that the industry is not only involved after disasters strike with compensation, but can also participate in loss prevention assessments and dialogues.

The rising awareness of the insurance sector can be seen in its engagements in multiple European and global policy frameworks that support climate change adaptation (CCA) and eco-DRR (e.g., European Union's Floods Directive, the Sendai Framework for Disaster Risk Reduction (DRR, 2015–2030), the Sustainable Development Goals and the COP Paris Agreement (2015)) (Warner et al. 2009; Surminski et al. 2015, 2016; Nussbaum et al. 2017; Cremades et al. 2018). EU Flood Directives are seen as bottom-up approaches making countries aware of their risk exposure. The frame of the Directives could be used to foster the implementation of

¹Economic losses from climate-related extremes in Europe, European Environment Agency, <https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2>

NBS. The on-going developments on the sustainable finance taxonomy, the European Green Deal to a low carbon future, offer a significant window of opportunities for the NAS concept to be used to promote effective green investments in resilience.

While there is growing evidence of NBS benefits, the assessment of the Natural Assurance Value (NAV), the reduction of risks that NBS can produce is still an emerging process within the insurance industry (Narayan et al. 2016, 2017; Colgan et al. 2017). The chapter aims to fill the knowledge gap by demonstrating the beneficial uses of a catastrophe modelling approach, developed by the industry, to quantitatively estimate the avoided damage thanks to the implementation of NBS on insured damages. Catastrophe modelling offers a powerful framework to estimate the economic damage caused to property from natural disasters. Such models are routinely used in the insurance industry globally to help insurers and reinsurers price and manage catastrophe risk. Case studies on NAS (e.g., Chaps. 6, 14, and 13) show that the (re)insurance industry could effectively use catastrophe modelling, in combination to scientific partners knowledge on co-benefits assessment, to assess the effectiveness of NBS.

In this Chap. 3, we first conceptualize the assurance value of nature and its current implementation within the (re)insurance industry. Next, we present the different roles of insurers in loss prevention using the on-going awareness of the sector in assessing preventive measures to focus their interest on NBS.

3.2 Evaluation of the Natural Assurance Value (NAV) Integration within the (Re)Insurance Industry for Now and for the Future

3.2.1 Methodology

Traditionally, the main focus of researchers has been on the consequences of climate change on the insurance business rather than insurers role in responding to climate impacts (Surminski et al. 2015). This chapter considers how insurance can support loss prevention and action for Climate Change Adaptation (CCA).

It is based upon findings from several research activities. First, an in-depth literature review on the different European natural hazards insurance business models has been performed (Marchal et al. 2019). Then a “country fact sheet – do you know European natural hazard insurance system well?” for 11 countries were designed. In addition, the literature provides more references linking climate change, disaster risk reduction, NBS and the insurance industry (European Commission 2017; Francis et al. 2016; Narayan et al. 2016; WBCSD 2017; World Wildlife Fund 2017; Weingärtner et al. 2017; Tipper and Francis 2017). Interviews were performed with (re)insurers (Marchal et al. 2019) to assess current status and potential opportunities for the sector to target loss prevention actions. Taken as a whole, this broad set of information has the advantage of providing a robust picture of the current integration of NAV within the (re)insurance industry.

3.2.2 *Fit for Today?*

The engagement in loss prevention by the insurance industry began with insurers specialized in industrial risks coverage. This branch of the industry has had a strong sensitivity to risk culture, particularly for fire and theft prevention. Increasing experiences with losses in these areas, the sector expanded its work with prevention measures and we observed its diffusion into general home insurance for fire and thefts. It was not the case for natural hazards prevention. Indeed, the industry considered that it was not its role to be involved in natural hazard prevention (Fédération Française de L'Assurance 2015b).

One reason is that the industry considers thefts/fire prevention as individual measures that can be financed by insurers for the reduction of damages (e.g., alarms, remote monitoring etc.). These individual measures reduce individual exposure with a direct effect on the insurance premium value. On the contrary, natural hazards prevention measures are often considered as collective measures (e.g., dikes, NBS). Since these are considered as collective prevention, these measures are differently integrated or challenge their integration within the insurance business. For example, in some countries (e.g. those with mandatory insurance coverage), it is not possible to adjust premiums according to the presence of collective protective measures, as the premiums are flat-based and not risk-based (Le Den et al. 2017). On the contrary, voluntary insurance schemes can manage premiums according to the risk exposure. There are however examples of natural hazard insurance schemes that can link the insurance industry to loss prevention. This is the case in France, for example, through the Barnier Fund and article L-121-1 of the Insurance Code which considers the integration of loss prevention. The current commitment of the insurance industry to support NBS development depends on the national natural hazard insurance scheme and the degree of loss prevention considered within. The main limit is the delay of awareness by the insurance industry to consider natural hazard prevention as an area where these could intervene. On the contrary, individual measures at the building level against natural hazards can be financed by insurers (e.g., moving electrical sockets higher, sand bags) (Association of British Insurers 2016). It is related to the on-going involvement of the industry to encourage land-use policies, building codes and build-back-better measures as resilient tools against disasters (Association of British Insurers 2016; Michell 2016; Le Quesne et al. 2017; Nussbaum et al. 2017; Leymarie 2019).

3.2.3 *Fit for the Future?*

Affordability, availability and solvability are the main challenges for the natural hazards insurance schemes, depending on their specificities, to cope with growing insured damage costs (European Commission 2013a; IPCC 2014; Munich Re 2017). Extreme events are going to be more frequent with climate change (physical

risk) and without any adaptive measures, insured damage costs of natural disasters will largely increase, as well as premiums (underwriting risk) (see Chaps. 13 and 14, (Moncoulon et al. 2018)). Thus, with the expected more frequent and intense events, the industry' risk solvability is challenged to maintain damage caused by natural events to tolerable limits. If the risks are not well assessed and anticipated, the premiums will increase making insurance contracts unaffordable notably at high risk areas (market and reputational risks). This may lead to an increase in the insurance coverage gaps and create risk exposure through spatial segregation. It could also lead to the bankruptcy of the system and the burden could then fall on corporates or states the impacts of which include lower future investment and high credit exposure. Improved knowledge about future expected risks is necessary to avoid unanticipated losses and to understand loss prevention. Natural hazard risk prevention measures can therefore become necessary to ensure both affordability and insurability to avoid future coverage gaps.

The more that physical risks occur, the higher the interest on prevention. Exploring this insurance's interest throughout NBS fits the objective of maintaining risk exposure and premiums to an affordable level in a climate change context. Potentially, the risk reduction benefits will be integrated into premium calculations, notably for schemes pricing premiums depending on historical claims data and not on current risk exposure. Currently, the pricing of individual risks is based on a statistical view and not on a risk-by-risk analysis. It is still too early to be able to model and to price every risk. For example, in France it runs counter to the principle of solidarity based on flat premiums. In other words, the same amount of premium (env. €20/year/household) is paid for natural hazards insurance. That challenge takes on its full meaning with the European policy objective to raise insurance coverage rate in some countries where the rates are currently low (European Commission 2013b; CRO Forum 2019).

Nevertheless, currently most of the collective preventive measures are not considered for premiums calculations. It is rarely done in some countries with risk-based scheme or even in risk maps. The integration of prevention measures (grey or NBS) relies on the availability of internal catastrophe models and research and development tools that can model the consequences of prevention on damages.

The specific demand for studies on the role of NBS has largely emerged in the past years and is in constant development (see Chaps. 13 and 14, or Lloyd's Tercentenary Research). A high-performing analysis of NBS requires specialized capacities accompanied by the assessment of co-benefits through the intervention of experts in the area. Insurers can help evaluate avoided damage related to NBS by using catastrophe models integrating NBS effects on hazard reduction and related impact on insured losses. The science behind the NBS is under development and while the physical effects of natural disasters can be modelled, the full extent of nature's role on hazards is complex to model. However, enough is known to state the importance of nature in risk reduction to integrate NBS into the catastrophe models, even while considering the uncertainties.

Overall, information disclosed about risk exposure and avoided damages through NBS will be useful for decision making processes. It is a way for achieving tandem

efforts with local authorities. Risk informed decision making encourage forward thinking, policy development and investments in longer term projects as exemplified by NBS.

3.2.3.1 The French Example to Mainstream Insurers' Involvement into Loss Prevention: The Barnier Fund and the GEMAPI Policy

In practice, protection measures, including NBS, are already funded by insurance companies in France through the Barnier Fund mechanism (FPRNM, Fonds de Prévention des Risques Naturels Majeurs). The mechanism was created by the Law n°95-101 of the 2nd February 1995. It is funded by a 12% levy on the additional premium linked to the compulsory extended natural catastrophe coverage on all property damage insurance contracts (Law 82-600 of the 13rd July 1982, Fig. 3.1). The Barnier Fund is funded by taxpayers.

This fund is dedicated to reducing vulnerability of the assets (local communities and homeowners) exposed to natural hazards. It is used for different risk reduction measures, both DRR and vulnerability reduction measures: studies and works (up to 50% of funding), structural protective measures and different measures such as amiable land acquisition and targeted communication to raise risk awareness. Nevertheless, it is not dedicated for maintenance or reconstruction.

The repartition of the funding allowed by the Barnier fund are: 70% dedicated to dike rings, 20% towards slowdown water engineering and 10% for adaptive measures. The related repartition is relatively stable over the periods 2003–2009, 2011–2016 and 2016–2017.

This fund is mono-specific this means that it will preferentially fund a prevention project that is dedicated to a single hazard risk reduction. The special case of NBS with co-benefits and multi-hazard effects is challenging its use to fund NBS implementation (see discussion in Chap. 14 on the Brague case study).

In France, Water Agencies can also finance NBS and local departments can support up to 20% of financing of protective measures for residential and professional areas, particularly in rural areas. In addition, the GEMAPI policy (Integrated Management of Aquatic Environments and Flood Prevention) aims to create an integrated water cycle governance at intercommunal authority level. Water agencies support local and regional authorities to implement GEMAPI jurisdiction. The objectives are a combination of river management and flood prevention based on natural measures. GEMAPI uses NBS to better protect catchment communities in an upstream/downstream relationships.

We can briefly exemplify one example of NBS implementation in France through the Barnier Fund (Fig. 3.1). The Isère-Amont project for the protection of Grenoble city in the frame of the 2012 French action plans for flood protection (PAPI). Four partners are involved to fund the project: the Isère Department, the Water Agency Rhône Méditerranée Corse, the two local intercommunalities and the State through the Barnier Fund and PAPI funds.

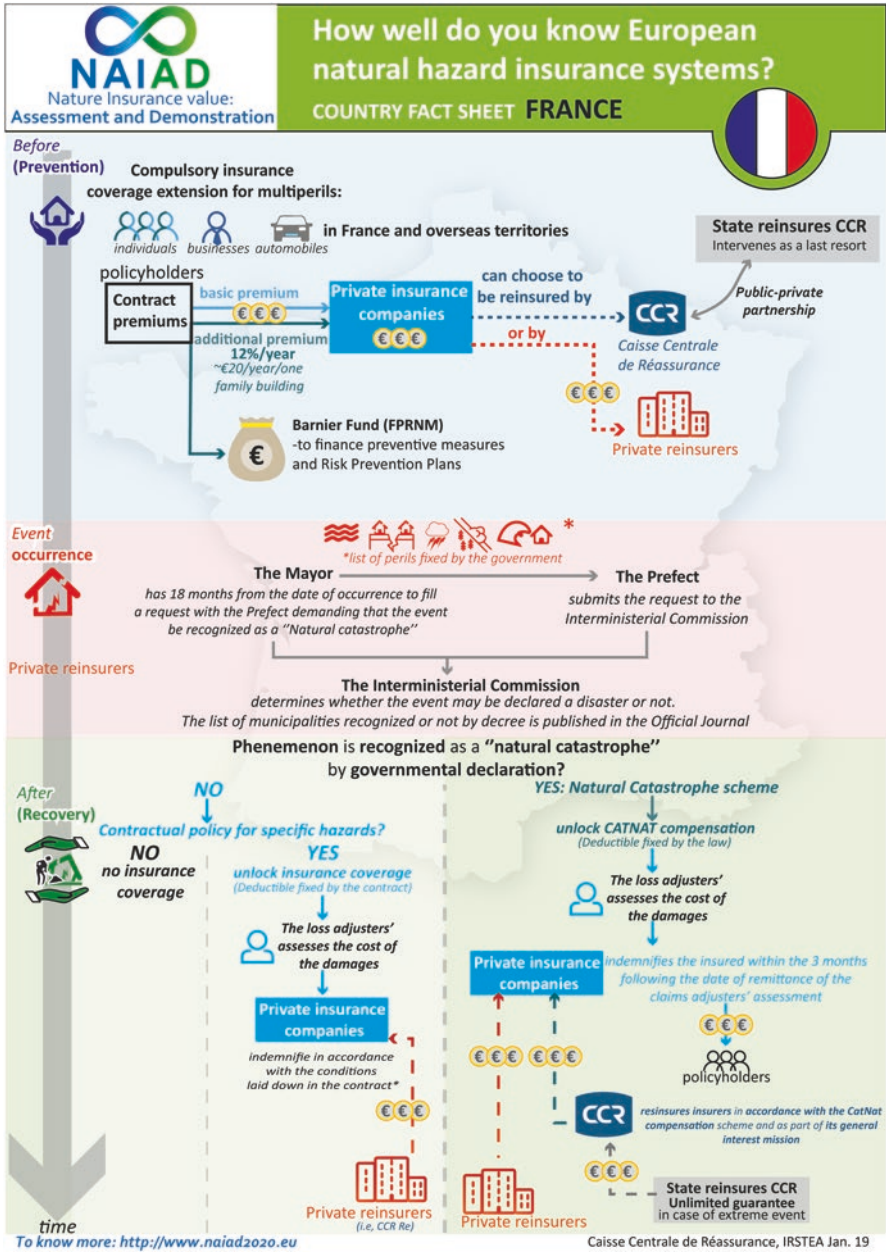


Fig. 3.1 Country Fact Sheet, explanation of the French natural hazards insurance scheme. Extract from a series of 11 country fact sheets. (Source: NAIAD H2020, authors' own)

The objective is to protect urbanized areas through the concept of giving-room-for the river using floodable field areas. A large part of the programme is dedicated to valorizing co-benefits related to the NBS such as the protection of the local natural heritage of the Grésivaudan valley and to mainstream appropriation of the riverbanks by the inhabitants for recreative activities and urban movement using bikes. These flood expansion areas are not only located on agricultural areas but also on forest areas to reconnect the alluvial forest and wetlands areas to the river. Dikes were then displaced behind the alluvial forest areas. The project is fitted to the GEMAPI policy. A total of 16 flood expansion areas were implemented to hold around 35 million of cubic meters of water for the potential flood event, namely the 200-years return period flood of the Isère River. The NBS is operational with a 30-years flood event and up to the 200-years flood event, in which case the damages were estimated at €1 billion.

3.3 The Different Roles of Insurance

The following section is based on results and typology of the roles of insurance as discussed in Marchal et al. (2019). This section does not aim to replicate this research, but to navigate the main issues and provide a clear and up to date view of the insurance roles in CCA and DRR for NBS.

Beyond the claims management role of the (re)insurance industry once damage is incurred, increasingly focus is on increasing efforts towards the implementation of preventive actions, before, during and after a natural disaster. The on-going changes in the industry are highlighted in this part with an exemplification of the potential actions of the industry with a longer-term perspective. We discuss the role of insurance as service providers, investors, innovators and partners.

3.3.1 *Insurers as Service Providers*

This role is materialized in practice by forward-looking components alongside risk modelling and the continuing formation of loss adjusters.

First, some of the company are integrating preventive measures (grey, NBS or hybrid) into their catastrophe models. The main challenge is to model preventive measures and their consequences on hazard reduction, it is related to access to data and to the scientific knowledge available. The insurers are not expert in NBS functioning, and in co-benefit assessment, it is necessary to combine knowledge of scientists with insurers' expertise on damage. A lot has to be performed to find a frame to increase that kind of collaboration. Nevertheless, in the literature there are some relevant examples of the use of catastrophe modelling to value the hazard reduction benefits from NBS (Beck and Lange 2016; Maynard et al. 2017; Reguero et al. 2018; Caisse Centrale de Réassurance 2018).

Second, the sector is encouraging better formation of loss adjusters, actuaries and catastrophe models teams. It supports also early warning alerts to insured properties with instructions to be followed to contain and/or avoid damages. Thanks to their special relationship with insured people, the sector participates in the awareness-raising of the population, which can be residential, commercial, and industrial agents, through the diffusion of educational information such as:

- Sharing maps dedicated to assessing hazard exposure;
- Vulnerability assessments;
- Sharing information on regulatory and opportunity to finance loss prevention projects;
- Sharing information of good practices before, during and after a natural event.

The sector is also developing specific location exercises on crisis management for natural disasters, which constitute a non-negligible interest in sharing risk culture.

3.3.2 Insurers as Investors

Insurance companies are changing how they invest in light of climate change. In the context of integration of Environmental, Social and Corporate governance criteria (ESGs) the investment of the industry in NBS projects could take multiple forms. The set of policies previously presented (ESGs, Green Deal, Sendai Framework, etc.) frame decision on strategic sustainable investments to adequately support society financial resilience.

While the sector is slowly moving towards long-term risk investments (multiannual financial framework), it is traditionally involved in short-term investments. Long-term investments require high-quality data to clearly understand the risk exposure and appropriate investments vehicles. To date, the role of the industry in financing is more in the allocation in alternative projects such like green projects, especially for energy production. A large disinvestment in the coal industry is currently underway due to the assessment of transition risks related to carbon sectors.

These investments take the form of the bonds as the primary financial tools. Catastrophe Bond, Climate Bond and Green Bond markets are not new (1992), but the novelty is that corporate sector (banks, insurers etc.) and local collectivities – since the signature of the Paris Agreement (2015) – are issuing an increasing number of bonds.

A new type of bond, Resilience Bonds is emerging. Their potential to incentivize investment in prevention, and therefore hopefully in NBS, is large since these are designed to fund risk reduction projects via a resilience rebate that turns avoided losses in to a revenue stream. The Climate Bonds Initiative and the Green Bond Principles have been developed to assess and to standardize bonds issuance. Nevertheless, these still only represent a small portion of the amount of bonds issued. In addition, as the frame is not specifically targeted and related to insurance as users.

A key issue is to promote actions to not only make bonds available, but to push for the insurance industry to catalyze ‘green’ investments in risk reduction measures with these bonds, like the sector already does for green energy. One example is the case of a low-carbon investment strategy framed as responsible investments (UN Environment Inquiry and MATTM 2016). This could be linked to the NBS role as part of CCA strategies. Ecosystems (mangroves, peatlands) or NBS that sequester greenhouse gases (Tuffnell and Bignon 2019) could be evaluated as an asset with values incorporating the amount of carbon these can capture. Based on it, the insurance sector could be interested to finance this kind of green projects, as disinvestment from carbon energy. Nevertheless, it is important to focus on getting investments in NBS as resilience investments for risk reduction where carbon reduction is seen as a co-benefit.

It is also worth noting that NBS along with co-benefits can also be eligible to multiple funding sources from multiple scales. The water quality improvement potential NBS can also trigger special funding from, for example, water agencies. NBS could benefit from multiple funding sources that could be pooling options with co-financiers. Eligibility from multiple funding sources is a financial opportunity to absorb risk exposure among partners (public authority, water agencies, national funds and the private sector). The complexity of exploiting these multiple sources is however often encountered in the way the current national investment planning systems and even private investment planning practices follow a sectoral and siloed approach. Nevertheless, no individual insurance company will finance a preventive measure alone at the watershed scale. Indeed, each insurer in the area will have only a sample portfolio of the global at-risk buildings in the exposed areas. This discussion is related to the business model and to the NAS chapter of this book. The bond mechanism could be one of the solutions, as well as sponsorship programs, where the insurance industry may have a role in financing NBS in this kind of scheme.

3.3.3 *Insurers as Innovators*

There are opportunities for insurers to push innovation across multiple areas of their competences to mitigate natural disaster risks. The research and development departments of insurance companies can have a tremendous impact on scientific innovations. The industry is now, for example, developing specialized skillsets building upon a catastrophe loss modelling framework. Efforts are needed, however, to take greater advantage of technical innovations and progress made throughout the sector. This could help harmonize the level of knowledge and practices among companies to speed up the uptake of the state-of-the-art methods and practices.

Innovations in insurance products used in the market are also emerging. There is a growing demand, for example, in specialized weather-related insurance products,

including parametric products or micro-insurance (see CCRIF example²). Other innovations in insurance product development can be used to spread risk and allow cities to pool their insurance protection. For example, a coastal municipality that faces a primary risk of coastal flooding can create a common coastal insurance product to cover that risk. Another innovation related to NBS is the possibility to ensure a natural environment, such as the case of the parametric insurance policy to cover Mexico coral reef.

The insurance industry can then become as an innovator into two areas. First, at a global level with the development of financial and insurance products. Second, from a territorial perspective, companies rooted at a catchment or city scales can foster the promotion or sponsorship of activities for loss prevention.

3.3.4 Insurers as Partners

Globally, the insurance industry serves as an important institutional partner for sharing risk knowledge and providing assessment of the countries exposure by working with the OECD, the World Bank, the European Commission, the Disaster Risk Management Knowledge Centre (DRMKC), the World Forum of Catastrophe Programmes, etc. This enables important opportunities for the exchange of knowledge, practice, and expertise among the insurance industry and with scientists that can consider the diversity of insurance schemes. These exchanges in these kind of areas can unlock partnerships to provide studies on the consequences of climate change on insured damages.

Partnerships at the national and local level may be even more critical. At the national level for example, the industry often relays information from the State and delegated ministries regarding risk preventive policies to its customers. In France, for example, insurers share information on on-going actions performed by the Directorate-General for Risk Prevention (DGPR in French). It is perceived as a social obligation to improve risk knowledge globally. In practice, the (re)insurance sector is interested to reduce the impacts of climate change by not only providing financial resilience but also sharing knowledge on risk management.

Partnerships between insurers with national and local authorities often also support the development and implementation of building codes, land-use planning, flood hazard zone regulations, resilience engineering and other measures. One area that can be expanded upon in future partnerships are efforts to promote build back better measures, as well as collective NBS prevention. This requires that the insurance industry participates in decision-making processes by providing simplified evaluations of water risks and information on loss data. In relation to this, the on-going discussions about sharing insurance data with communities or scientists is a key issue. A notable European example can be found in Norwegian cities, where

²The Caribbean Catastrophe Risk Insurance Facility (CCRIF) www.ccrif.org

data sharing from the insurance companies has been applied to improve municipal authorities knowledge on the specific locations of their exposures to risks that can support planning measures taken (Danish Insurance Association et al. 2013; Berg et al. 2014). Nevertheless there are some limits. The first limit for sharing data is to ensure protection of personal data since the insured claims and policies are address-based and geo-localized. The second limit is linked to the market and commercial information available in that kind data. In that context, the industry is willing to be considered as a partner in risk assessment and not as a data provider. As for example in some countries, the involvement of the insurance sector to support planning in the form of public-private partnerships to assess to effectiveness of protective measures through cost-benefit analysis. The NAIAD project, the Oasis platform, research performed by The Nature Conservancy and Lloyd’s or French examples of research performed by CCR for local communities etc. Or again, it could take, for example, the form of investments capital towards research companies.

Figure 3.2 summarizes the four roles of the insurance industry in loss prevention and questions raised for insuring NBS. Currently only a few schemes and protective measures are insured. In the case of NBS, the time return to normal situation and temporality of rebuilding is longer than grey measures. In the frame of an insurance contract for NBS, the compensation by insurance could be done only if a natural disaster strikes. The definition of an NBS value could be the insurance value

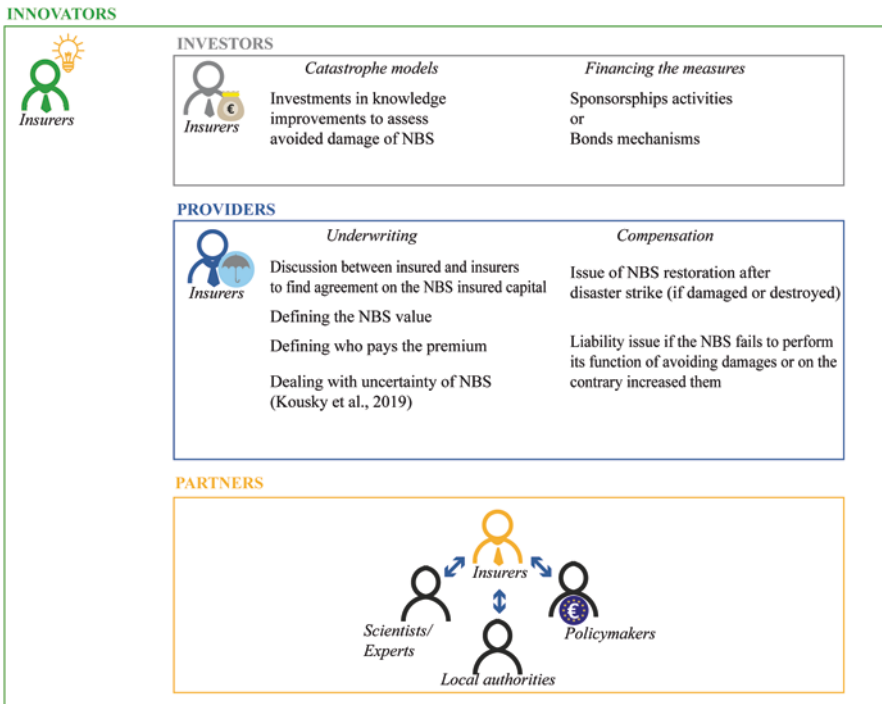


Fig. 3.2 Exemplifying insurers’ roles and challenges for insuring NBS. (Source: authors’ own)

(avoided damages and co-benefits). There are other aspects that require careful consideration and planning. For example, if one links an NBS to environmental liability insurance, it is complex to assess and to provide values to an environmental area and to replace that area to the same status if it is damaged by pollution or destroyed by a natural disasters. The rebuild and replacement costs are important and complicated issues. There are some interesting ways to address this that have been proposed. One potential method is to target the premium buyer as the global beneficiaries of the NBS, such as cooperative of farmers, cities, hotels, tourisms association as did e.g., (Francis et al. 2016; Tipper and Francis 2017).

3.4 Conclusion

This chapter highlights the (re)insurance industry's role in NAS and initial progress to integrate the concept in the sector. Analyzing evidence of the effects of NBS to cope with climate change adaptation and disaster risk reduction is critical in this process, which is why the analysis done within case studies should of great interest to many in the insurance industry (see case studies chapters) for more detailed analysis.

Thus the main key lessons and recommendations can be summarized as follows:

- **Maintaining sustainability of the insurance system under climate change is a critical challenge for societies worldwide.** The biggest threats to the industry arise from physical and transition risks. Weather catastrophes threaten the entire insurance business, regardless the specificities of the national insurance schemes. If change towards sustainable and resilient economic development is not taken, both economic and human losses from the physical impacts will be far more severe. The transition risks will be manageable for companies that are well-prepared, and opportunities will arise from changes in society and technology used to support low emissions and natural carbon capture. The maintenance of affordable insurance coverage is crucial to fill the low diffusion rate gaps (i.e. the protection gap). Insurers support people and companies to tackle risks. The development of strong risk modelling knowledge and risk awareness can make a big difference to supports systems to enable risk transfer. It offers unique financial capacity to support society's recovery and to cope with uncertainty. It would have a major impact in achieving the SDG2030 agenda to insure vulnerable poorest group physical and financial resilience perspective.
- **Insurers' have an important role to engage in and support society in CCA and DRR, including NBS, and efforts in these areas should expand further.** It no longer appears to be a question of whether NBS have an impact on natural hazards, but how much value they present through the Natural Assurance Schemes (avoided damage and co-benefits). The role of NBS in raising systemic resilience and making at-risk areas insurable again is strategic; therefore, it contributes to close the protection gap issue. It offers the opportunity for the sector

to provide affordable insurance in new areas and thus grow their markets while developing risk knowledge. A coordinated assessment is required to assess as much as possible their effectiveness.

- **The insurance sector can contribute to develop knowledge on natural hazards in a changing climate and in the systematic examination of NBS in risk industry models.** The number of studies on the effectiveness of NBS in loss prevention are growing but this field is still under development. A continuous improvement of tailored catastrophe models is needed to ensure a correct vision of the natural hazards and of NBS. This includes innovating with new products, managing investment portfolios in a way that mainstream NBS in the protection of assets. It also includes support through providing other benefits, t partnerships with local authorities or scientists to increase knowledge on risk and loss and how to manage them. It is a long-term process for the insurance sector to move towards prevention. In the future, systematic examination of NBS by using catastrophe modelling should become a new standard practice.
- **The development of policies in the area of NBS will have to consider the diversity of insurance schemes between countries.** It is important for the sector to be onboard during the policy discussions and requires clear policy recommendations to link sectors working on the same questions for a continued dialogue on CCA and DRR. Thus it is particularly the case for the on-going discussions on data sharing. Considering the efficacy of EU Directives to frame the opportunity for low and high penetration gap to support knowledge improvement on NBS (relevant example of the Floods Directive).
- **Broad multi-stakeholder collaborations will be needed to take full advantage of NAS through NBS projects.** Commitment, engagement and investment of time, knowledge and resources are needed from many actors, ranging from urban planners, architects, insurers, land managers, and management authorities to design and construct NBS. These actors can also support projects linking research institutions to the public institutions and private companies involved.

References

- Association of British Insurers (2016) ABI guide to resistant and resilient repair after a flood. Association of British Insurers, London
- Beck MW, Lange GM (2016) Managing coasts with natural solutions, guidelines for measuring and valuing the coastal protection Services of Mangroves and Coral Reefs. World Bank Group, Washington, DC
- Berg H, Ebeltoft M, Nielsen J (2014) Flood damage survey after a major flood in Norway 2013: cooperation between the insurance business and a government agency. In: University of the West of England Wessex Institute of Technology (ed) Flood recovery, innovation and response IV. Norwegian Water Resources and Energy Directorate, Norway, pp 227–235
- Caisse Centrale de Réassurance (2018) Retour sur les inondations de janvier et février 2018, modélisation des dommages et évaluation des actions de prévention. Caisse Centrale de Réassurance, Paris

- Cardone A (2018) Experts urge more prevention efforts, financial resilience to manage disasters. In: Xinhuanet. Available via http://www.xinhuanet.com/english/2018-11/23/c_137625274.htm. Accessed 25 Feb 2020
- Colgan CS, Beck MW, Narayan S (2017) Financing natural infrastructure for coastal flood damage reduction. Lloyd's Tercentenary Research Foundation, London, p 44. <https://doi.org/10.7291/V9PN93H3>
- Cremades R, Surminski S, Mañez Costal M et al (2018) Using the adaptive cycle in climate-risk insurance to design resilient futures. *Nat Clim Chang* 8:4–7. <https://doi.org/10.1038/s41558-017-0044-2>
- CRO Forum (2019) The heat is on insurability and resilience in a changing climate emerging risk initiative – position paper. CRO Forum, Amsterdam
- Danish Insurance Association, Finance Norway, The Federation of Finnish Financial Services, Insurance Sweden (2013) Weather related damage in the Nordic countries – from an insurance perspective. Nordic Insurance Associations, Finance Norway, Insurance Sweden and The Federation of Finnish Financial Services
- European Commission (2013a) Greenpaper on the insurance of natural and man-made disasters. European Commission, Brussels
- European Commission (2013b) An EU strategy on adaptation to climate change. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, Belgium
- European Commission (2017) Horizon 2020 work Programme 2016–2017 in the area of climate action, environment, resource efficiency and raw materials. European Commission, Brussels
- Federation Francaise de L'Assurance (2015a) Impact du changement climatique sur l'assurance  horizon 2040. FFA, Paris
- Federation Francaise de L'Assurance (2015b) Livre blanc pour une meilleure prevention et protection contre les aleas naturels. FFA, Paris
- Francis A, Armstrong Brown S, Tipper AW, Wheeler N (2016) New markets for a land and nature. How natural infrastructure schemes could pay for a better environment. Green Alliance, London
- IPCC (2014) 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. Cambridge University Press, Cambridge/New York
- Lawrynuik S (2019) Insurance companies push cities to take climate action. In: The Sprawl. Available via <https://www.sprawlcalgary.com/insurance-companies-push-climate-action>. Accessed 26 Feb 2020
- Le Den X, Persson M, Benoist A et al (2017) Insurance of weather and climate-related disaster risk: Inventory and analysis of mechanisms to support damage prevention in the EU. EU Publications, p 196. <https://doi.org/10.2834/40222>
- Le Quesne F, Tollmann J, Range M et al (2017) The role of insurance in integrated disaster & climate risk management: evidence and lessons learned. MCII, United Nations University and GIZ, Bonn
- Leymarie J (2019) Climat: le cout des dommages pourrait augmenter de 50% d'ici 2050 selon le reassureur CCR. Available via France Info https://www.francetvinfo.fr/replay-radio/l--interview-eco/climat-le-cout-des-dommages-pourrait-augmenter-de-50-d-ici-2050-selon-le-reassureur-ccr_3212029.html. Accessed on 29 Mar 2019
- Marchal R, Piton G, Lopez-Gunn E et al (2019) 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* 11:6212. <https://doi.org/10.3390/su11226212>
- Maynard T, Stanbrough L, Stratton-Short S, Belinda H (2017) Future cities: building infrastructure resilience. Lloyd's of London/Arup, London
- Michell N (2016) The new role of insurers in resilience planning. In: Andrews J (ed) *Cities Today*. Cities Today, London, pp 26–30

- Moncoulon D, Desarthe J, Naulin JP et al (2018) Conséquences du changement climatique sur le coût des catastrophes naturelles en France à l'horizon 2050. Caisse Centrale de Réassurance, Météo-France, Paris
- Munich Re (2017) Natural catastrophes 2016 analyses, assessment positions, 2017 issue. Munich Re, Germany
- Narayan S, Beck MW, Wilson P et al (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 25. <https://doi.org/10.7291/V93X84KH>
- Narayan S, Beck MW, Wilson P et al (2017) The value of coastal wetlands for flood damage reduction in the Northeastern USA. *Sci Rep* 7:9463. <https://doi.org/10.1038/s41598-017-09269-z>
- Nussbaum R, Schwarze R, Surminski S (2017) 20 – Economic resilience, Total loss control and risk transfer. In: Vinet F (ed) *Floods*. Elsevier, pp 297–320
- Reguero BG, Beck MW, Bresch DN et al (2018) Comparing the cost effectiveness of nature-based and coastal adaptation: a case study from the Gulf Coast of the United States. *PLoS One* 13:e0192132. <https://doi.org/10.1371/journal.pone.0192132>
- Surminski S, Kool D (2016) Taking a risk on the weather. In: *Financial World* (ed) *Financial world*, pp 49–53
- Surminski S, Aerts JCJH, Botzen WJW et al (2015) Reflections on the current debate on how to link flood insurance and disaster risk reduction in the European Union. *Nat Hazards* 79:1451–1479. <https://doi.org/10.1007/s11069-015-1832-5>
- Surminski S, Bouwer LM, Linnerooth-Bayer J (2016) How insurance can support climate resilience. *Nat Clim Chang* 6:333–334. <https://doi.org/10.1038/nclimate2979>
- Tipper AW, Francis A (2017) *Natural infrastructure schemes in practice: how to create new markers for ecosystem services from land*. Green Alliance, London
- Tuffnell F, Bignon J (2019) *Terres d'eau, terres d'avenir "faire de nos zones humides des territoires pionniers de la transition écologique"*. Assemblée Nationale, Sénat, CGEDD, Paris
- UN Environment Inquiry, MATTM (2016) *Report of the Italian National Dialogue on Sustainable Finance. Inquiry: Design of a Sustainable Financial System*. Geneva Switzerland
- Warner K, Ranger N, Surminski S et al (2009) *Adaptation to climate change: linking disaster risk reduction and insurance*. United Nations Office for Disaster Risk Reduction (UNISDR), Geneva
- WBCSD (2017) *Incentives for natural infrastructure, review of existing policies, incentives and barriers related to permitting, finance and insurance of natural infrastructure*. World Business Council for Sustainable Development (WBCSD), Geneva
- Weingärtner L, Simonet C, Caravani A (2017) *Disaster risk insurance and the triple dividend of resilience*. Overseas Development Institute (ODI), London
- World Wildlife Fund (2017) *Natural and nature-based flood management: a green guide*. World Wildlife Fund (WWF), Washington, DC

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

