Chapter 2
A Reader's Guide to Natural Assurance Schemes

Elena López Gunn, Laura Vay, and Carlos Marcos

Highlights

- Natural assurance schemes emerge from a structured methodological approach with a number of sequential steps.
- The main aim of a natural assurance scheme is to mitigate the impact from water related risks (avoided costs and damages) and additional co-benefits.
- Natural assurance schemes can be implemented at any scale (micro, meso and large) to cover water related risks like floods and droughts.

2.1 Introduction

This Reader's Guide presents the overall framing for this book, introducing and explaining the logic for the structure in the main sections of the publication, based on the main conceptual framework around natural assurance schemes (or NAS for short), underpinning the book. It looks at the main methodological components, the integration of these components and their testing in specific real-life conditions in nine case studies.

The aims of this chapter are fourfold:

1. First to provide a Reader's guide for different potential users and readers for this book to help navigate the content of the book, and the sections that might be more relevant depending on the specific aspect sought.

E. López Gunn (✉) · L. Vay
ICATALIST S.L., Las Rozas, Madrid, Spain
e-mail: elopezgunn@icatalist.eu

C. Marcos
Confederación Hidrográfica del Duero, Valladolid, Spain

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2. Second to present the tools and methods (or "NAS toolbox and Methodological assessment frame") co-developed to assess the physical impacts of NAS and to value NAS in monetary and non-monetary terms. That is how these NAS can be turned into strategies and bankable projects to be fully developed and implemented. In short, to present the Natural assurance scheme assessment frame, tools and methods developed under different disciplines, by looking in detail at each of its components, as well as the sequence of analysis.
3. Third, by looking at concrete examples of how these methodologies, tools and methods have been applied and tested in nine case studies across Europe. In this in depth look at the case studies, we show the advantages and limitations of the NAS approach. It will be seen how the NAS assessment framework is a modular and scalable (flexible) approach, where some or all components can be applied to assess the role and value of nature-based solutions (NBS) and of nature-based strategies for mitigating the effects of water related natural hazards at the urban, peri-urban and catchment scale and linked co-benefits.
4. Fourth, to provide some preliminary thoughts on transferability to other contexts and location.

2.2 A Technical Expert and Researcher's Guide to Natural Assurance Schemes: The Assessment Frame

A modular methodological assessment was developed to help design natural assurance schemes. This modular approach has several elements, which cover a bio-physical, social, and economic assessment of the specific area where the scheme could be potentially implemented. The assessment frame can be applied at different scales from large basins like the lower Danube to small scales (in our case a football stadium in Rotterdam). What changes between scales is not so much the approach as the range of tools and methods to be deployed. The aim of this (modular) robust assessment framework is to provide a structured and replicable methodology for the testing, data collection and operationalization of the assurance value of nature-based solutions (NBS) as strategic investments for risk reduction, mitigation, and the valorisation of co-benefits. Also, for the monitoring and evaluation frame to be able to collect the evidence in a systematic way on their effectiveness to reduce or prevent risks and facilitate their replication.

In the case of biophysical assessments for the large scale, as described in Burke et al. (this volume, Chap. 4), the use of Eco:Actuary, a web based spatial policy support system - developed with the insurance industry and end users, to map and understand the biophysical basis to value natural capital for different stakeholders and events, as well as the impacts of land use and climate change upon it.

For other scales, like e.g., the city of Copenhagen, other tools are more suitable like the hydrological model MIKESHE or Bayesian Networks (BN), also known as belief networks (or Bayes nets for short). Hence, BNs combine principles from graph theory, probability theory, computer science, and statistic (Ben-Gal 2008). The tools, in many ways, must match the relevant decision support and planning scale and phase (as discussed in Basco et al. 2023 – this volume Chap. 7). Therefore, the right biophysical assessment tools and frameworks can support the eventual design and implementation of these nature-based strategies, capable of delivering the right (science/evidence- based) key performance indicators.

In terms of social assessment, the 'social man/woman' performs a number of functions like the establishment of social institutions that match social norms and rules, the forming of social organisations, formulating laws, principles and policies that turn social norms into the formal rules of the game, often crystallized into contracts to safeguard the existence, interest and social welfare of the community (in healthy social systems and institutions), or for the benefit of a smaller groups, while preventing or avoiding captured or clientelistic systems (like extractive institutions) (Singh 2006; Acemoglu and Robinson 2012). Its relevance to the natural assurance schemes is based on the level of collective action that must be facilitated to align the different interests and incentives of the different agents. For this, an understanding of their risk perception and their interests, as well as the current state of play (rules in norm and rules in use) is key. A range of tools and methods have been used to undertake the social assessment, mainly social network analysis, fuzzy cognitive maps, and ambiguity analysis (see Giordano et al. 2023 – this volume Chap. 5).

In terms of economic assessment, the project adopted a cost benefit analysis. In particular, the process of quantifying the costs and benefits of an NBS over a certain period, and those of its alternatives within the same period, in order to have a single scale of comparison and a robust and unbiased evaluation (Atkinson and Mourato 2015). The NAS economic frame gave specific attention to the economic benefits in terms of the economic advantages of designing and implementing a set of NBS (or more comprehensive nature-based strategies) over a certain period, quantifiable in terms of monetised costs and benefits, including generated cash flows. Also, the economic cost, i.e., the cost of designing and implementing a NAS over a certain period. It may include acquisition, management, transaction, damage, and opportunity costs (Naidoo et al. 2006). The cost benefit analysis specific to a NAS is one of the most important foundations and innovation that has been developed to construct a natural assurance scheme. This consists of several elements to estimate the costs with the use of life cycle costs of nature-based solutions vis-à-vis normal infrastructure and the opportunity costs, which as discussed in Le Coent et al. (2023, – this volume in Chap. 6) often refer to land use. In terms of benefits the focus was on combining the benefit from avoided damages, as well as other co-benefits, which is central to the definition of a NAS. An important element in the Natural Assurance frame is the link between the elicitation of pluralistic values through biophysical, social, and economic value assessments to a multicriteria assessment frame that can generate a set of key performance indicators. This can eventually be linked to the achievement of specific policy goals (or levels of service, as described by Altamirano et al., 2023 – this volume Chap. 9) and thus e.g., to potential impact investments.

2.3 A Planners, Business and Financial Guide: Integration of the Assessment Frame into Real Cases

The methodologies and tools developed were piloted in "DEMO Living Solution Labs" which in this book we call case studies (Dell'Era and Landoni 2014). These case studies span across diverse hazards, risks, scales, environmental and NBS contexts, to provide locally nuanced co-developed models and integrated analytical frames. The modular assessment frame of biophysical, social, and economic analysis was tested in nine different case studies with the main aim to integrate knowledge generated in real environments. Our Demonstration Living Labs (see case studies in Sect. 2.4) are innovation ecosystems, where research organizations collaborate with users and early adopters to create participative strategies to co-define, co-design, co-develop, and validate new products, services, and business models, in our case the development of Natural Assurance Schemes. For this kind of innovation cluster to succeed, effective practices must be implemented. The capturing of the full value of these nature-based strategies was integrated in several ways.

First, through its strong framing under adaptive planning as introduced by Basco et al. (2023 – this volume, Chap. 7) and analysed and discussed by Van Cauwenbergh et al. (2023 – this volume, Chap. 19). Adaptive planning is a structured, iterative process of robust yet flexible decision making in the face of uncertainty, with the aim to manage uncertainty over time through system monitoring and learning from what is experienced as the future unfolds. Using some of the models developed specifically for many of our case studies, it is possible to potentially develop Dynamic Adaptive Policy Pathways (DAPP), which is an iterative policy analysis process for adaptive planning that allows to adjust future action when events, that are presently unknown, unfold in the future. The DAPP approach combines "Adaptive Policymaking" with "Adaptation Pathways", and the developed plans include a strategic vision of the future, commit to short-term actions, and establish a framework to guide future actions. This was not implemented in our case studies, but it could be integrated into the current method.

Second, through the natural assessment business canvas that is explained in Mayor et al. (2023 – this volume, Chap. 8) and Mayor et al. 2021), the value proposition is elicited collaboratively. A business model is a conceptual tool containing a set of concepts and their relationship to each other, to fully develop the value proposition of a specific product or service. It allows for a simplified description and representation of what value is provided to customers, how this is captured, with which funding sources and its financial elements (Osterwalder et al. 2010; Osterwalder and Pigneur 2010; Burkhard et al. 2012; Raymond et al. 2017; Jarzabkowski et al. 2019). The NAS Canvas is different on two accounts; first, because it is structured based on a logic of supply and demand of ecosystem services, and because it is based on a pluralistic understanding of value (Jacobs et al. 2016) and relational values (Mouraca and Himes 2018). These are part of the IPBES Framework and defined as "… imbedded in desirable relationships (sought after), including those between nature and people" (Díaz et al. 2015). Therefore, the natural assurance business canvas captures not just the fully private values, but also the collective and public values, preparing the ground for the collective alignment of a number of interested parties and their collective co-benefits, and willingness to pay for different services provided by multifunctional solutions like nature based strategies (Fig. 2.1). These NBS often deliver simultaneously a bundle of services (collective benefits), i.e., the various benefits that can be provided by a NBS simultaneously over a certain period (Jiang et al. 2016).

Third, the financing framework for water security as described by Altamirano et al. (2023, – this volume Chap. 9), further develops and tests the "Better Business Case approach" (Smith and Flanagan 2001). This includes 5 elements of analysis (a) the "strategic case" to demonstrate that the proposed nature based solutions (or strategies) are strategically aligned and is supported by a compelling case for change, (b) the "economic case" to ensure that a wide range of investment options (in our case also comparing green, hybrid and grey options) have been evaluated and that the preferred option optimises value and benefits, (c) the "commercial case" to facilitate that any proposed procurement is commercially attractive and viable, which in relation to nature based solutions offers specific challenges, (d) the "financial case" to demonstrate that the preferred solution is affordable and can be funded, (e) the "management case" to provide a guarantee where processes and capabilities are in place to ensure that the preferred solution can be successfully delivered. In our case – as will be seen shown – quite often this is spearheaded by public authorities since these are often the problem owners and most exposed directly (or indirectly through their citizens and businesses) to natural hazards (Fig. 2.2).

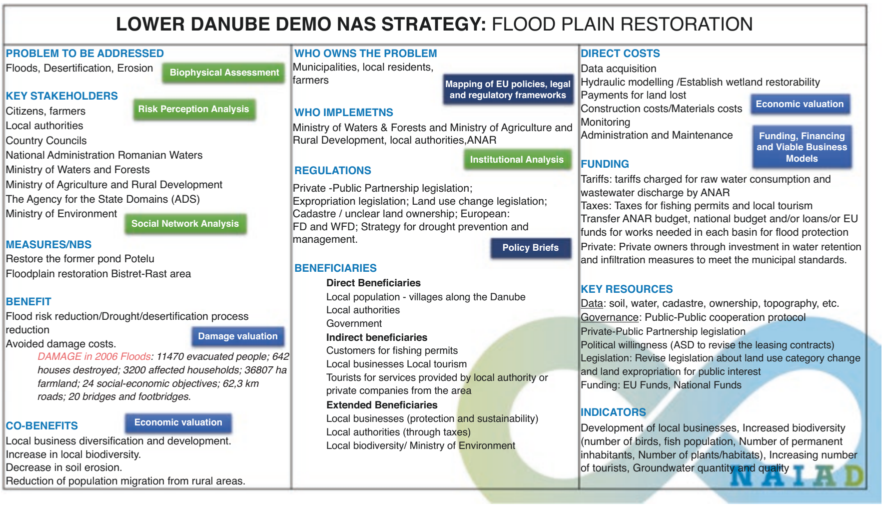

Fig. 2.1 Example of the NAS Business Canvas applied to the Lower Danube Natural Assurance Scheme. (Source: authors' own)

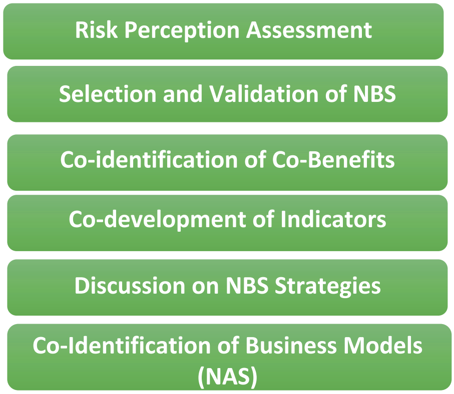

Fig. 2.2 Stakeholder engagement process to move from risk perception to socially acceptable natural assurance schemes. (Source: authors' own)

2.4 A Practitioner's Guide: Applied Case Studies

Our case study Living Labs or case studies span nine locations in eight countries across the European Union and the UK (Dell'Era and Landoni 2014). The methodological tools and methods described earlier are used and integrated in real place-based locations to operationalize the assurance value of ecosystems to reduce the human and economic cost of water-related natural hazards and water related risks like floods and droughts. Our nine case studies have different geographical spatial scales: micro, meso and large scale. These scales for example range from relatively large scales (>5000 km^2), mesoscale (200–2000 km^2) and some at microscale (<20 km). The spatial boundaries used to delineate our cases studies cover both rural and urban, with small river catchments like the Glinščica, the Lez or the Brague to entire river basins (16,000 km^2) and one large aquifer (5000 km^2). The urban scale in some cases ranges from the city of Copenhagen to a neighbourhood in the smallest case study with 4 hectares in Rotterdam.

An embedded case study methodology was adopted which provides a means of integrating quantitative and qualitative methods into a single research study (Scholz and Tietje 2002). This embedded approach and identification of sub-units allows for a more detailed level of inquiry (Yin 2003). This opens the possibility of considering EU level data, like e.g., the current SEEAW initiative in natural capital accounting.

Our case studies address different natural (water related) hazards. Most of our cases focused on floods as the main problem identified by the stakeholders. For example, Lez, Rotterdam and Brague are developing Natural Assurance Schemes that give particular attention to flash floods (pluvial floods). Other case studies like the city of Copenhagen are focused on how to manage cloud bursts and how to manage groundwater/waterlogging floods. This renders the soil unproductive and infertile due to excessive moisture and due to the creation of anaerobic conditions.[1] Meanwhile our case studies of Glinscisca, Medina and Lower Danube are dealing with river floods, one of the most common forms of natural disaster when a river fills with water beyond its capacity, and the surplus water overflows the banks and runs into adjoining low-lying lands, causing loss of human life and the damage of property.[2]

Nora Taylor[3] *from Live Science describes floods as follows: "Water from floods can take time to build up, allowing the population in an area time to be warned in advance. But sometimes flooding occurs quickly. Flash floods gather steam within six hours of the events that spawned them. They are characterized by a rapid rise of fast-moving water. Fast-moving water is extremely dangerous — water moving at 10 miles an hour can exert the same pressures as wind gusts of 270 mph (434 kph), according to a 2005 article in USA Today. Water moving at 9 feet per second (2.7 meters per second), a common speed for flash floods, can move rocks weighing almost a hundred pounds (aprox. 45 kg). Flash floods carry debris that elevate their potential to damage structures and injure people".*

All the case studies relied on a stakeholder engagement protocol which structured the process of interaction between the different stakeholders (public bodies, NGOs, SMEs, universities, cities, citizens), with the direct involvement of the insurance industry, end users and implementers as far as possible. In other words, these theoretical approaches and disciplinary assessments have been translated into a case study roadmap as an important step of the operationalization of NAS and the interdisciplinarity approach with inputs from a range of scientific disciplines (including social sciences). Stakeholders were defined as "individuals and organizations that have an interest in or are affected by your evaluation and/or its results". Another definition by the *Accountability 1000 Stakeholder Engagement Standard* defines stakeholders as "… those groups who affect and/or could be affected by an organisation's activities, products or services and associated performance". Stakeholders will each have distinct types and levels of involvement, and often with diverse and sometimes conflicting interests and concerns. This is relevant because one of the main objectives of the social assessment was precisely to undertake ambiguity analysis, seeing these potential divergences of opinions as a key area of research and knowledge gathering that can open opportunities for collaboration and collective action for mutual protection. The stakeholder engagement process is defined as "… the process used by an organisation to engage relevant stakeholders for a purpose to achieve accepted outcomes" in our case to develop a NAS.

[1] http://www.yourarticlelibrary.com/water/waterlogging/waterlogging-definition-causes-effects-with-statistics/61000/

[2] http://www.ehow.com/about_6310709_river-flood_.html

[3] http://www.livescience.com/23913-flood-facts.html

Fig. 2.3 Stakeholder workshops (co-design process). (Source: authors' own)

Through a co-design process, our stakeholders provided a reality check on the appropriateness and feasibility of proposed nature-based solutions, offering insights on the potential barriers and drivers to NBS, providing relevant feedback and recommendations to help Natural Assurance Schemes become actionable (Fig. 2.3).

Within this range, there is also a social and technical gradient of demos, from those where NBS have been already implemented (like Rotterdam- see Chap. 16) to those were the stakeholders had low awareness of the NBS options (Fig. 2.4). Through a process of co-design and the use of different tools and methods, an assessment was made of the water-related natural hazards in each demo. Therefore, through this social engagement process, the vulnerability aspects were addressed, i.e., the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR 2009). In the case of the Thames a new tool (Eco:actuary) has been developed which has analysed risk portfolios with consistent multi-hazard analysis and data, focused on process-based and spatially specific information to evaluate the role of NBS for natural flood management (Mulligan et al. 2023 – this volume Chap. 12).

For the specific cases of Medina, Glinščica and the Lower Danube, the social acceptance of NBS was also studied. What social barriers exist towards NBS acceptance and implementation, and an analysis of the institutional settings that will hamper or accelerate the setting up and adoption of a NAS.

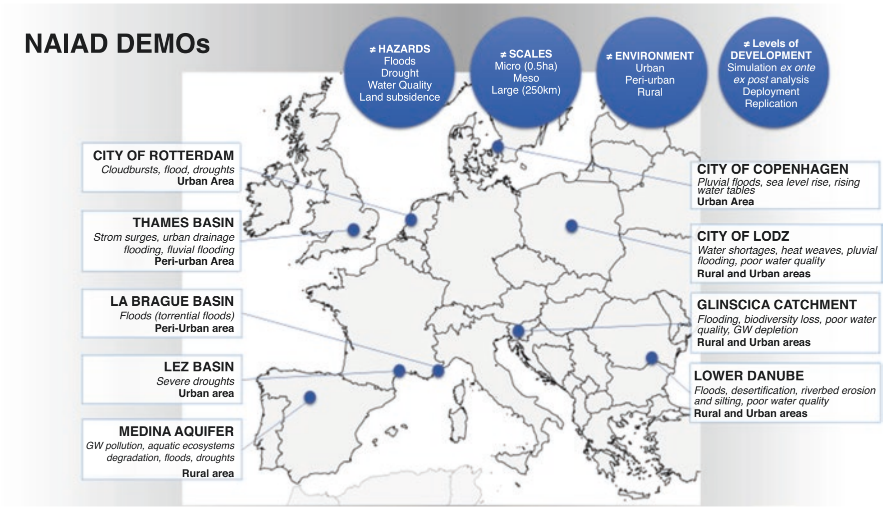

Fig. 2.4 Summary of case study Living Labs. (Source: authors' own)

Other case studies, in particular the Lez and the Brague (Le Coent et al. 2023, this volume Chap. 14, and Piton et al. 2023, this volume Chap. 13) were able to undertake a full economic assessment to evaluate the economic costs and benefits of green (NBS) and grey solutions, along their life cycle, considering implementation costs, opportunity costs, assurance value (diminished risks costs or avoided damages from natural functions) and co-benefits (productive market values and environmental values).

The integration of these different modular components in the case studies, has allowed to develop several decision supports tools for stakeholders and a common integrated and the holistic evaluation framework of Natural Assurance Schemes. Furthermore, the case studies – once their nature-based solutions and strategies were identified – have developed a set of business models for their nature-based strategies as natural assurance schemes.

Through capacity building activities, including their contributions to the preparation of a MOOC, case studies have been supported to identify how these natural assurance schemes could be funded and financed in the future, to identify the most relevant sectors and actors, funding streams and financial options.

This has produced a toolkit of plausible business cases that will facilitate the implementation of NBS for increasing the resilience towards natural hazards, including an online Handbook on Financing (Altamirano et al. 2021). The approach has a fundamental orientation towards co-design, developing a continuous stakeholder and end user engagement process in each case study, with interviews and workshops. The approach aims to also facilitate policy dialogues in the political arena on key topics through a set of policy roundtables and dialogues as summarised in Table 2.1.

Table 2.1 Summary of Natural hazards addressed and NBS selected as Nature bases strategies

Scale	Case study	Hazard(s) addressed	NBS selected	Lead Agency
Large	Thames	River floods	Retention ponds landscaped as recreational areas; Conservation agriculture- changes in soil tillage to improve infiltration; Leaky dams, Forest protection and afforestation; Restoration of wetlands	Environment Agency
	Medina	Drought and River floods	MAR (managed aquifer recharge); Crop change (to crops more adapted to CC and droughts); Soil conservation; Reforestation; Small dams; Water re- use	Duero River basin agency
	Lower Danube	Floods and Droughts, erosion	Building retention areas Forest windbreak expanded network. Creating buffer zones dedicated to flood prevention. Smart sediment management Reconnecting former wetlands	Rumanian Waters
Medium catchment	Brague	Flash floods	Riparian woodland and large dead wood integrated management Giving room to the river; Large retention areas Small natural retention areas, cumulated area ~200 ha; Widening of the Brague river bed (~10–40 m); Wetland restoration (11 ha); Riparian forest restoration (13 ha)	CASA: Brague Basin Agency
	Lez	Pluvial floods	Green infrastructure: bioswales, open vegetated retention basins, green roofs; city deproofing; conservation of agriculture and natural land through urbanization strategies; Karst active management	City of Montpellier
	Glinscica	River floods	Re-meandering & Re-vegetation; Opening natural floodplains; Small multi-functional dry retention areas; Roof rain water tanks; Remove crosswise barriers/ dams	City of Ljubljana

(continued)

Table 2.1 (continued)

Scale	Case study	Hazard(s) addressed	NBS selected	Lead Agency
Small	Rotterdam	Pluvial floods	Biofiltration (Constructed wetlands); Buffer / retention; Aquifer Storage & Recovery (ASR)	City of Rotterdam
	Lodz	Pluvial floods, droughts, heat waves	Blue-green network; Green ring around the city; Woonerfs; Pocket parks; Green backyards; River rehabilitation; Reservoirs and biofilters in the city	City of Lodz
	Coppenhagen	Pluvial floods, groundwater floods, cloudbursts	Green infrastructure (parks, green beds etc). Retention areas where water is kept and evaporates. Retention areas in which stormwater is infiltrated to groundwater; Blue infrastructure (surface channels) (Retention areas from which stormwater is routed to open waters (e.g. harbour); LAR (SUDS) solutions (Stormwater from roof areas is collected in local urban drainage systems and locally infiltrated	City of Copenhagen

Source: Authors'own

Therefore, our chapters (from Chaps. 10, 11, 12, 13, 14, 15, 16, 17) summarise the experience of our pilot methodologies in nine case studies across diverse risk and NBS contexts to provide locally nuanced co-developed and tested examples.

2.5 A Policy Maker's Guide: Policy Uptake of Natural Assurance Schemes

One of the main aims of this publication is to make the results of our Natural Assurance schemes methods, tools, testing and implementation accessible and useful to different stakeholders like policy makers, insurers, water users, etc. Frameworks and tools are used to support of NBS planning and implementation (gathering evidence of the effectiveness of the measures implemented).

On a higher level this publication aims to help identify and address specific barriers and opportunities for the uptake of NBS and natural assurance schemes and how to strengthen or develop policy instruments, business models and innovations in this area to prevent and reduce risks to increase water security.

One of the main areas, based on the interaction with the insurance sector is the different ways in which insurance companies, re-insurance, and public authorities (particularly cities and regional governments/basins) can incorporate nature into risk reduction and the awareness of their co-benefits. In the context of the EU Green Deal, the Sendai Framework (UNISDR 2015), the Paris Agreement and the SDGS, together with the EU adaptation strategy (EC 2021), These can help us to identify robust opportunities based on evidence-based policy making and science-based impact investments and to provide the knowledge base to increase funding for NAS implementation.

In relation to funding and finance, it is important to consider NBS and nature-based strategies in relation to potential budget reallocations in view of the implementation of new ambitious EU strategies under the EU Green Deal umbrella through the multiannual financing framework. In terms of policy the book wants to contribute to the area of ecosystem-based adaptation and eco DRR, i.e., how Natural Assurance schemes can contribute to adaptation, understood as the adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects and impacts in order to alleviate adverse impacts of change or take advantage of new opportunities (Adger et al. 2005). For example, green adaptation is an application of eco-engineering and aims at adaptation to the pressures of climate change, population growth and economic development, making use of ecosystem services. Ecosystems can adapt to changing circumstances and therefore, might be more robust in the light of climate change under lower temperature increase scenarios. The approach has a strong connection to protection and support of local communities and their livelihoods. One area where this contribution aims to add is to facilitate adequate training and capacity building, which this book hopes to support and promote.

2.6 Conclusions

This Reader's Guide has outlined the main structure of this publication in relation to main concept(s) analysed, the methodological assessment of key elements (biophysical, social, and economic), which are then integrated through a series of adaptive planning, business models and financing, which are tested and developed in nine case studies.

In terms of conclusions, key lessons, and recommendations we can summarise these as follows:

- First, the development of so-called Natural Assurance Schemes, which are characterized by the incorporation of the quantified avoided damages and the qualified co-benefits which create a value proposition for *ex ante* investment in nature-based solutions for risk reduction and well-being. The focus is mainly on how to increase loss prevention knowledge (and the tools designed to do so), raising awareness on the potential of NBS for risk reduction and co-benefits.
- Second, as will be seen and described in other chapters, a set of methodologies have been developed to assess NBS. This set of tools and methods can be used as

modular components to develop Natural Assurance Schemes. The tools used are scalable, and the methods have to be matched with the scale and the hazard to be addressed in a process of co-design with the local stakeholders through a structured stakeholder engagement protocol. The focus of this methodology development has been the concept of the assurance value of ecosystems. An EGuide is now available for others to further develop the development and implementation of natural assurance schemes.
- Third, the different key elements need to be integrated to provide the full perspective on nature-based solutions and all their multifunction, following an adaptive planning approach that would make it easier for the lead agencies (like e.g. cities, regions or basins) to incorporate these solutions as part of their DRR and CCA portfolio. The business canvas facilitates the elicitation of plural values spanning the fully private benefits, collective and public good elements. The financing framework, with attention to the five "better business case" for natural assurance schemes that can then help take the natural assurance schemes from design to full implementation (including their funding and finance).
- Fourth, our nine case studies served as real life spaces for the validation of methodologies by feeding and retrofitting our methodologies. Insights from theory to practice and which has led to a better alignment between science and practitioners, offering tools to better understand, assess and implement NBS. By testing methodologies in different contexts, institutional settings, scales, climatic regions and risk types, etc. created a baseline for future actions and for how to use ecosystem services to mitigate water risks (i.e the assurance value). There is impact on methods used by the case studies to finally quantify processes (risks, vulnerability, potential, etc.). Furthermore, due to the macro, meso and microscale of our case studies, there is a focus on NBS across scales & the importance of scale in relation to e.g., effectiveness.
- Fifth, natural assurance schemes are policy relevant because one of the main aims is to shift earlier in the risk management cycle to prevention and mitigation in line with Sendai's risk paradigm. It also helps to support the implementation of the EU Water Framework Directive and the EU Floods Directive by incorporating green infrastructure and e.g., natural flood management and natural water retention measures as part of the risk management portfolio. Finally, it also supports other clear policy objectives on biodiversity and climate change commitments, as outlined in the new EU Biodiversity Strategy and EU Adaptation strategy, as well as facilitate training material with methods accessible to decision makers and technical experts that allow for the greening risk reduction with NBS as part as the curriculum of water managers and decision makers.

We hope that this book provides a useful reference for those aiming to produce their own natural assurance schemes to reduce risks while putting value in nature's protection.

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