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INDEX

Edition information	2
1 EXECUTIVE SUMMARY	4
3 Introduction	5
4 Innovation and Learning from the NAIAD Project	7
4.1 An Engineer's Challenge: Assessing NBS flood mitigation	7
4.2 An Economist's Challenge: Evaluating NBS with Cost-benefit analysis	11
4.3 A Financer's Challenge: Finding bankable NBS business cases	14
4.4 An Insurer's Challenge: Using insurance schemes to push NBS & DRR	18
5 DEMO Case Stories: Tales from Three Catchments	22
6 Conclusions	25
7 References.....	26
About the NAIAD Project	27



1 EXECUTIVE SUMMARY

The NAIAD project explored the interlinkages between effective climate change adaptation policy, nature-based solutions (NBS) and the opportunities to better link to insurance sector policies and practices. It focused on NBS that are used for water-related projects, especially related to disaster risk management (DRM) and/or climate adaptation. This report highlights what has been done in the NAIAD project to address, innovate and learn to overcome challenges to the financing and implementation of NBS projects. This report provides insights gained from demonstration projects to show factors that enable or dissuade uptake of NBS. It will also look from the insurer's perspective on the challenge, drawing experience from NAIAD on how insurance schemes both impact and can support NBS and DRR in Europe. Each section concludes with a summary of recommendations based on this learning from the NAIAD project for actions that can be taken to advance green infrastructure strategies, climate adaptation and ongoing dialogue with the insurance sector.



3 Introduction

The NAIAD project explored interlinkages between effective climate change adaptation policy, nature-based solutions (NBS), and insurance sector policies and practices. NAIAD focused on NBS that are used for water-related projects, especially related to disaster risk management (DRM) and/or climate adaptation. In this report, we highlight opportunities and recommendations for the EU to further support the mobilization of green infrastructure as effective tools for climate change adaptation by building on the relevant learnings and resources from the NAIAD project¹.

Evaluating gaps to implementation of NBS

The recent *Review of progress on implementation of the EU green infrastructure strategy* (EU 2019) concluded that “experience illustrates that ecosystem-based approaches such as GI, nature-based solutions, ecosystem-based adaptation, natural water retention measures and ecosystem-based disaster risk reduction measures are cost-efficient policy tools; but they are not used to their full extent and their potential should be further strengthened at EU level.” This

¹ The analysis and findings in this report draw upon a wide range of inputs from the NAIAD project (2017-2020) reports and insights shared during public events. Key reports include : *Guidelines on the Eco:Actuary Policy Support System for understanding the role of Natural Flood Management (NFM) in flood mitigation* (D2.5); *Economic water-related risk damage estimation* (D4.3); *DEMO Insurance Value Assessment Report* (D6.3); *From Bankability to Suitability report: value capture and business models to catalyse implementation of NAIAD demo's NAS strategies* (D7.2); *Handbook for the Implementation of Nature-based Solutions for Water Security: guidelines for designing an implementation and financing arrangement* (D7.3); as well as the previous report produced in this work package, *Mapping Insurance value in EU Policy frames Study Report* (D8.1) and *policy brief and roundtable reports* (D8.2 and 8.3) (all reports can be found at <http://naiad2020.eu/media-center/project-public-deliverables/>).

On January 14 2020, a policy roundtable event was held in Copenhagen, Denmark entitled ‘Insurance and investment in resilience through nature-based solutions: Learning from across Europe’ aimed to bridge the experiences of the DEMOs with larger policy questions and modalities for engaging insurers and facilitating investment in NBS. The event included presentations and moderated dialogue between insurers, urban authorities, financiers and regulators as well as direct pitching for scaled investment in demonstration NBS projects and feedback from real investors on their pitches. Speakers and participants were insurers/regulators (e.g. James Orr, Chief Actuary for General Insurance, Prudential Regulation Authority Bank of England; Francisco Espejo, Consorcio de Compensacion de Seguros, Spain; Sergio Casterllari, European Environment Agency) and financiers/investors (e.g. Philip Lamotte, Courtnell Partners, impact investor; Raphaelle Vallet, Manager, Sustainable Finance, Green Investment Group, Macquarie Capital; Lauren Ferstandig, Deputy Managing Director, Origination, NatureVest; Stephen Hart, EIB, Natural Capital Financing Facility). Insights from the event based on the experiences from the NAIAD DEMOs working to access financing for NBS projects informed the writing of this report.



demands answers to key questions: if NBS are cost-effective, what impedes their implementation? And how can these challenges be overcome? There are several obstacles frequently cited that limit NBS implementation. Common theories can be grouped by the roles seen as the primary obstructions:

Theory 1: It is an engineer's problem. This assumes that a primary obstacle for NBS is the lack of evidence around and/or performance of NBS relative to traditional infrastructure assets. Thus, projects are effectively stopped by technical project development staff before they reach the stage of arranging financing. To ensure this does not happen, effective performance assessment methodologies must be mainstreamed so practitioners have confidence in using them.

Theory 2: It is an economics issue. This assumes that the difficulty of assigning economic value to ecosystem services is the primary obstacle for arranging funding, especially around cost-benefit analyses (CBA) — which are normally a critical aspect of finance preparation and qualification. To ensure this does not happen, integrated CBA methodologies are needed to capture all values.

Theory 3: It is a financing challenge. This assumes there is a lack of investor demand because financing institutions may be averse to NBS, not aware of them, and/or lack appropriate finance instruments to fund them. A better diagnosis of the finance challenge, however, may be described as a “market gap”. Under investment in NBS is seen as a failure, at large, of those looking to access financing to produce viable projects to sustain and pay back investment. It also, however, signals a failure in the market where the value of services provided by NBS may be undervalued, or the values provided are not monetized sufficiently or through other KPIs to enable investment, or familiar finance instruments seem ill-fitted to non-traditional investments. Each of these scenarios may require public sector interventions and be better considered within NBS/GI strategies.

The following sections of this report highlight what NAIAD did to address, innovate and learn to overcome challenges in these areas. It will also look from the insurer's perspective, drawing experience from NAIAD on how insurance schemes both impact and can support NBS and flood risk reduction in Europe. It then provides insights gained from three of the demonstration projects to show factors that enable or impede the uptake of NBS. Each section concludes with a summary of recommendations based on these learnings from NAIAD.



4 Innovation and Learning from the NAIAD Project

4.1 *An Engineer's Challenge: Assessing NBS flood mitigation*

Understanding the issue:

As part of a NBS or green infrastructure planning for a flooding process, it is imperative to know the capacity of the NBS under consideration in order to ensure that it large enough to mitigate the levels of peak flow at the asset at risk. This assessment is built into the design process for grey infrastructure which is built to an exact specification, however the capacity of NBS are often more difficult to assess in a complex and changing landscape.

The impact of NBS for flooding (often described as a Natural Flood Management (NFM)) is also difficult to assess because of the rapid decay in influence downstream of the interventions, which are usually individually small interventions. The NFM needs to be close upstream to the assets at risk and large enough to store significant volumes of the observed peak flow in order to make a significant impact on them. Models can be used for large scale NBS strategy, but measurement is most appropriate for assessment of *in situ* NBS effectiveness because of the scale and nature of NBS and the cost of data for modelling at these scales (Burgess-Gamble et al, 2017). To date, much of the evidence regarding the impact of NBS interventions is modelled rather than observed and there is therefore little information on the performance, longevity, and operation and maintenance of such structures to be able to effectively cost these (Dadson et al., 2017).

What we did:

To address this gap, NAIAD has developed three new tools: //Smart Sensors, an Eco:Actuary Investment Planner and the Eco:Actuary Policy Support Tool. In short, these tools build confidence in NBS because they promote evidence-based decision making based on the monitored effectiveness of NBS measures.

The Eco:Actuary toolkit was designed to assess NBS at a number of different scales, from small interventions to large catchments. It features three key components:

//Smart:River and //Smart:Soil systems to perform in-field monitoring and web-based analysis of the effectiveness of specific interventions made.

Eco:Actuary web-based Investment planner to analyze the magnitude and type of interventions necessary to make a significant difference to observed flood peaks (through an empirical spreadsheet based tool). The EA Investment Planner (EAIP) assists decision makers to:

- see the monetary investments required to achieve a certain flood reduction target.



- directly compare the costs of three different types of NFM (leaky dams, regenerative agriculture and retention ponds) including maintenance costs (which is often overlooked when planning/costing) interventions

The Eco:Actuary web-based spatial policy support system to map risk, exposure, loss, mitigation and avoided loss for current natural capital and scenarios for climate and nature-based solution investments. The Eco:Actuary web (EA) based spatial support tool enables the user to:

- provide spatially explicit planning information (i.e. factors in the location of an intervention on its potential impact).
- determine the optimal site to place an NBS (to maximise protection of downstream assets)
- ‘virtually’ test what effect an NBS will have before it is implemented
- Interface with a process-based model, which is based on fundamental relationships between variables and does not require calibrating for particular site characteristics.

The EA Investment Planner and Policy Support Tool help during the planning stages so that the best NBS is selected and then sited in the optimal location (EA). Working with the Co\$tingNature Policy Support System, Eco:Actuary can also be used to assess co-benefits beyond hazard mitigation. All data are provided for application anywhere, globally.

What we learned

The Eco:Actuary fills an important niche in bringing climate change and green infrastructure to the world of catastrophe modelling. Inspired by the catastrophe modelling approach currently used by the industry, and after identifying gaps and weaknesses in existing catastrophe models, we developed the Eco:Actuary Policy Support System. Catastrophe models are used by the (re)insurance industry to calculate the likelihood and severity of potential future natural hazards by considering the hazard itself, the vulnerability of assets and an estimation of the financial losses caused.

The main strengths of catastrophe modelling are the detailed asset and insurance datasets (for modelled areas only), which allows a thorough assessment of asset exposure and vulnerability. However, not all parts of the world have good datasets, which leaves much of the globe without robust assessments of both natural hazard risk and the assets vulnerable to such hazards; and represents a major weakness of current catastrophe models. A second major weakness is that catastrophe models are very expensive, which limits their use by less affluent users. Based on our assessment of cat modelling we identified that both the (re)insurance industry and wider society would benefit from an improved flood catastrophe model.



Insurance companies have a very focused view of flood risk, e.g. to mitigate flooding in a very small but very expensive area such as a city. The disadvantage is that, by focusing only on the urban flood risk area itself where assets are at risk, means that the options for NBS that are available in urban, expensive areas are limited by space, often both ineffective and expensive. A catchment - wide approach is needed for NBS to be most effective. For example, by changing the farming practises upstream the excess rain that would flood downstream can be stored upstream of the cities in the landscape and flood risk can be reduced effectively and cheaply (Tipper and Francis 2017; Francis et al. 2016).

How we innovated

The Eco:Actuary Investment Planner is designed to address the issues of how large combined storage interventions need to be in order to achieve a target reduction in flood peak downstream for a gauged catchment, -and how much this volume of storage might cost. The Eco:Actuary spatial policy support system (PSS) complements this to enable assessment of how the placement of NFM in specific catchment positions can make a difference. It was developed using the EcoEngine framework that also underpins WaterWorld, Co\$tingNature and a range of other PSS.

Eco:Actuary is focused on assessing risks, exposure of multiple assets and their values and better understanding the mitigation of potential damage by existing green infrastructure and proposed green infrastructure interventions. It can do this for the current status of climate and land use and for scenarios of combined climate, land use, asset value and asset adaptation (damage function modification) change. As well as providing current (baseline) data for hazards, risks, damage etc., the Eco:Actuary Policy Support System can address the challenges of climate change as the IPCC Global Climate Model scenarios can be run in the system. This means that users can explore how climate change will affect flood risk. The effect of climate change can also be combined with changes in land use to explore potential futures. Though intended to become multi-hazard in the long term, Eco:Actuary currently covers only flood. Like all policysupport.org PSS Eco:Actuary is applicable anywhere globally based on datasets provided with the model. As a physically based model the EcoActuary PSS can be used in gauged catchments or catchments without a flow gauge.

Recommendations of the use of NAIAD results

- **Eco:Actuary can provide value to the (re)insurance industry through the global flood modelling capabilities and scenario analysis.** There will however be numerous beneficiaries beyond insurance, as everyone will benefit from the model being open-access.
- **Eco:Actuary has global coverage and is free for non-commercial purposes which removes the two major barriers with exist in catastrophe models.** This focus on risk



mitigation and user empowerment are ways in which Eco:Actuary diverges from the currently available-flood risk tools of the (re)insurance industry.

- **The ability of Eco:Actuary to run climate change scenarios, as well as alter flood parameters, and to add/remove green and grey infrastructure, is a considerable contribution to cat modelling functionality.** For the vulnerability and financial components of cat models, the insurance industry requires detailed information on asset vulnerability including information on claims history, individual building characteristics, as well as the impact of various insurance coverage terms. The typical outputs of a cat model are average annual loss and the annual probability of occurrence: flood risk is typically expressed as return intervals (i.e. 1 in 200 year flood, 1 in 100 year flood). Eco:Actuary produces different outputs as it presents outputs spatially, in the form of maps. For any given location specific values can be extracted from the maps: such as, the monetary value of assets at risk of flooding at any location. An advantage of displaying results in map form is that it is an accessible tool to communicate risk to a wide variety of stakeholders.



4.2 *An Economist's Challenge: Evaluating NBS with Cost-benefit analysis*

Understanding the challenge

Assessing the value of costs and benefits of NBS so that these can be compared to alternative strategies of services provision is fundamental to convince decision makers to develop these solutions. The EU factsheet on green infrastructure and climate change adaptation notes that providing a “stronger evidence base on the multiple benefits of GI, quantifying both the economic and social benefits and avoidance of costs” is needed to accelerate investment and uptake of NBS in Europe (EC 2014). Improvements in valuation methods can support decisions to address water risks that consider NBS as options and determine strategies that maximizes value for investment.

What we did

NAIAD developed applied methods for economic assessment of proposed NBS in multiple demonstration areas (Demos). The assessment fully implemented in three Demos (Brague, Rotterdam and Lez) and partially implemented in four others (Lower Danube, Thames, Medina del Campo and Copenhagen)². The overall aim of the economic assessment methodology is to assess the economic value of alternative actions aiming at managing water risks, through a Cost benefit Analysis (CBA), which provides an evaluation of the economic efficiency of a series of measures as NBS strategies (potentially as part of a project). The principle of the CBA is to compare an alternative with-the-project with a counterfactual baseline alternative without-the-project, generally referred to as the Business As Usual (BAU) alternative. The CBA requires the estimation of all direct and indirect costs and benefits for the different NBS strategies under study. The following typology of monetary values associated with NBS strategy were considered:

- **Cost of implementation** are those that are necessary for the implementation and maintenance of the NBS included in the NBS strategy (e.g. Life cycle costs).
- **Opportunity costs** are those that are foregone with the NBS strategy, for instance areas that are taken out of production or land that is used for NBS and that cannot be used for other purposes. These are the indirect costs of the NBS strategy.
- **Avoided damages** are the damages avoided due to the reduction of water risks generated by NBS strategies. Avoided costs are the primary benefit generated by NBS strategies.
- **Co-benefits** are the additional environmental, economic, and social benefits generated by NBS. The CBA evaluated only those that could be assessed monetarily. This excludes

² See <http://naiad2020.eu/demo-cases/> for information about the demo cases of the NAIAD project.



many co-benefits generated and reflects only a portion of the overall value of the NBS. Depending on the case study, one or several alternatives are compared which incorporate different levels of NBS and traditional grey infrastructure.

What we learned

Our results confirm previous evidence that the cost of implementation and maintenance of NBS strategies is lower than the cost of grey solutions for the same level of risk management. In the Rotterdam and Brague cases, for example, the NBS solutions were assessed to cost 15% and 63% less than grey infrastructure solutions to provide the same level of flood mitigation.

While performing better than grey infrastructure alternatives, the assessments however also show that the benefits in terms of avoided damages provided by the NBS were not by themselves sufficient to cover the capital expenses and operation and maintenance costs to implement them. There are factors to consider, however, to fully evaluate the cost-effectiveness of NBS measures:

- **Co-benefits** generated by the NBS can be very large. In the cases stated above, the value provided through co-benefits were assessed as even greater than those created through flood risk reduction.
- **Opportunity costs** for an NBS, particularly for land use, can have large impacts on its overall cost advantages. As NBS are often implemented over large areas of land, this can be an important factor in places where the cost of land may be very high, such as cities. **NBS are very heterogeneous.** There was no clear cut conclusions on the overall economic efficiency of NBS in our assessments. Cases where benefits outweigh the costs were found (e.g. Lez and Medina); but there were also cases where they did not (e.g. Rotterdam and Brague). Again, it is important to mention that the economic efficiency of grey solutions is far worse in these two cases.

There were several limitations to the economic assessments that should be noted when reviewing these conclusions. These are as follows: i) the evaluation of damages focused on direct insured damages and underestimated total avoided damages ii) only the monetary value of NBS benefits were assessed, excluding non-monetary indicators that may play a strong role in the political decision making process, iii) estimations bear large uncertainties. Among the possible improvements, the implementation of a Multi Criteria Decision Analysis (MCDA) would be an important complement to assess NBS by including non-monetary indicators.



Recommendations for use of NAIAD results

- **NBS aiming at solely reducing water risks cannot be assumed to be economically efficient.** Thorough case specific economic valuations of a diversity of strategies, involving NBS, grey and hybrid solutions, are needed to identify best options for water risk management and to address territorial challenges.
- **NBS often appear to be economically efficient only when all the benefits generated are considered.** Policies and investments from single sectors, however, are generally conditioned to a positive cost-benefit analysis on the specific benefit they target, such as for example risk reduction in our cases (flood or drought). The large share of co-benefits in the overall value of NBS can be difficult to align within sectoral investments. This has strong implications on NBS funding and business models and points to opportunities for cross sectorial investments to capture all the benefits.
- **Strategies are needed to translate co-benefits into revenue flows that can be used for project funding.** As many co-benefits are public goods, it is not straightforward to identify revenue flow and may require public sector intervention. In the project preparation and assessment, the implementation of a Multi Criteria Decision Analysis (MCDA) may also be needed to support assessment of non-monetary key performance indicators.
- **Rules applying for the public funding of NBS should therefore be adapted in order to take into account cross-sectoral benefits of NBS.** This would be in line with e.g. the Flood Directive advocating for more integrated flood management and a plurality of measures including the use of NBS as part of the portfolio of measures.



4.3 *A Financer's Challenge: Finding bankable NBS business cases*

Understanding the issue

In recent years, very significant developments have occurred in producing financing mechanisms in this area, such as the creation of bonds that explicitly signal to investors that the project has environmental benefits and/or contains NBS components (e.g., green and climate bonds), the emergence of private-public partnerships that explicitly look at ecosystem functions and interventions for investment (e.g., Flood Re in the UK), and the EU sustainable finance initiative's approach to develop a new regulatory framework that can encompass new and emerging issues (e.g., climate adaptation, NBS). Explosive growth has occurred in the green and climate bonds market in recent years, expanding from upper-income countries (USA, western Europe, Australia) to middle-income countries (China, India, Brazil), including lower-middle income countries (e.g., Nigeria).

Indeed, year-on-year market growth of 30 to 100 percent over the past decade for green and climate bonds suggests that the real obstacle may be a lagging supply of projects rather than a lack of potential financing. This shortage of bankable projects requires not only capacitation to enable proposals with improved business models, but also can require shifts in financing processes that can better understand and value what these projects offer. Financial institutions retain a low level of conceptual understanding around how to best appreciate the special risks and challenges around water and climate change, especially for NBS, retaining relatively weak top-down assessment methodologies. Worse, many institutions continue to handle climate risks as the responsibility of ESG and CSR staff rather than as issues that directly influence value and financial credibility (and long terms business viability for some sectors).

All this considered, the greatest challenge faced may be convincing and enabling those taking the debt finance to build an NBS and that will have to pay back their loan. Now it is much more possible to get a loan to implement an NBS but the lack of awareness of the investor (those taking the loans to finance a project) of the advantages of NBS relative to more traditional infrastructure investments and a lack of political will by regulators - or other public policy groups to encourage or favor NBS- remain important obstacles. Procedural issues come into play as well. Concern over transaction costs and requirements on staff resources are also likely slowing adoption of more effective and progressive approaches to both climate risk assessment and mitigation options.

For plans and projects to access funding and financing it is necessary to prepare a full business case for the entire investment program and each of the projects that make part of this investment program. In simple terms, what in the scientific and advocacy world could be considered a project, within investment cycles it is still considered an idea. For this idea to



become an investment project that can be assessed for bankability and/or investability, many more details and evidence needs to be gathered and more clarity needs to be achieved regarding the way NBS proposed will be designed, paid for and who will implement.

The criteria and level of detailing regarding implementation costs and risks differ greatly between the project descriptions of NBS proponents and the requirements for allocation of public funding or granting of loans by impact investors. Identifying the “business model” for an NBS project - including a quantified value proposition, the elements required to deliver this value (resources and stakeholders), the costs of delivering this value, the range of beneficiaries and potential pool of clients and the associated possible revenue streams – will be an essential step to build a convincing business case that reduces the perceived risk by investors, while identifying the possible mix of funding sources to cover whole range of lifecycle costs.

What we did

NAIAD partners developed a **Handbook for the Implementation of Ecosystem-based DRR** (Altamirano et.al 2019). The handbook takes the Financing Framework for Water Security (FFWS) and tailors it for use in NBS projects. A crucial element towards the development of an NBS business case of a suitable implementation arrangement per NBS must cover five elements: strategic, economic, as well as commercial, financial and managerial business case. The FFWS aims to serve as a guideline to “engineer” an implementation arrangement – choosing from a wide range of project delivery and finance options that vary from purely public governance options up to the creation of markets for private initiatives. This covers: a) the transaction (e.g. type of good and project characteristic), b) the level of service required over time and c) the institutional setting (stakeholders, strengths of local government, private sector and community and the incentives created by formal and informal institutions)(see box 1).

Box 1: Design of an implementation arrangement: Financing Framework for Water Security (Altamirano 2019, p 13)

Step one: Define the main services the project will create and categorize this in types of economic goods. It is important here to bear in mind that we categorize the services the asset created by the project delivers, not necessarily the asset itself. For example, a forest may provide services that can be considered private (such as reduction of sedimentation rate of hydropower plants), yet the forest itself may be a public good. This categorization enables the identification which types of funding could be appropriate to ensure cost recovery.

Step 2: Funding strategy: The funding of a project could be either public or private. In general terms the main sources of funding are what the OECD called the 3 T's: Taxes, Tariffs or Transfers. Once the sources of funding – who ultimately pay for the project- are determined the mechanisms to arrange capital upfront (financing) and how to place the project on the market (procurement) are selected.

Step 3: Financing strategy: Depending on the type of project and whether the project sponsor is public or private, a variety of financing instruments could be used. In the graph below we show for example a variety of innovative financing instruments for Climate Adaptation and DRR (Altamirano et al. 2019¹).

Step 4: Procurement strategy: This refers to the way in which the government agency or private project sponsor responsible for the project can choose to make use of or to purchase the project. The graph shown here applies mainly to public infrastructures, while other sectors or types of transactions may need a different approach, such as the design of regulated markets or bottom-up community-based initiatives. As is shown in this graph in case of public procurement of infrastructures the government may choose to tender it as a full integrated contract (e.g. involving the private sector all the way from planning up to Operation and Maintenance) or choose for more traditional separate ones.



NAIAD also developed the Natural Assurance Schemes Business Canvas that can be used for the identification of potential business models and the required elements for NBS implementation (See figure 1). It serves as a fairly comprehensive framework to describe the features of an NBS implementation initiative. It diagnoses the type of information required and available to report the results in a way that is useful for engaging and convincing investors and attract interest on this type of initiatives.

How we innovated

The Handbook for the implementation of Ecosystem based DRR supports the development of multiple ‘cases’ that are needed for a project:

- strategic (outlining the need for change);
- economic (why the “preferred strategy” optimizes funds);
- commercial (how the program is organized to make its implementation achievable and attractive for market players);
- financial (whether it is affordable in local/national economies);
- management (how, and by whom, it will be implemented).

The NAS canvas framework is an adaptation of the traditional business model canvas, which is traditionally used to support companies and businesses in identifying and structuring their value proposition and the elements required to develop a strong and feasible business model for the delivery of a product or service to the market. The NAS Canvas is expanded to include a wider range of users (not just businesses and commercial) for the delivery of services to the market, to public authorities and collectivities. The NAS canvas builds on this traditional business canvas model proposed by Osterwalder and Pigneur (2010) and is expanded and tailored to account for the specificities of climate adaptation services and NBS. It is composed of 8 clusters that go through the different steps required to identify the elements composing a business model for the valuation of risk reduction services and other associated benefits (see figure 1).

Recommendations of the use of NAIAD results

- **The Handbook for the implementation of Ecosystem based can be used to support proponents of NBS to create structured project plans and implementation strategies.** This makes it easier to engage with public authorities and private investors.
- **The NAS business canvas can be applied to any NBS project or strategy in order to identify the most suitable business model for the case.** Applications to NAIAD demos show that the tool is suitable to any type of NBS-hybrid strategy, including green, grey and/or soft measures, at any scale (large basin, small catchment or city).



Figure 1. NAS Canvas Framework



LEZ DEMO NAS STRATEGY: DEVELOPMENT OF GREEN INFRASTRUCTURE IN THE LEZ BASIN					
CLUSTER C. SUPPLY		CLUSTER A. FLOW OF ES SERVICES		CLUSTER E. DEMAND	
4. WHO IMPLEMENTS		1. PROBLEM TO BE ADDRESSED		9.WHO OWNS THE PROBLEM	
Municipalities, private and public developers, private owners		Serious and recurring flood risks mainly caused by runoff, air pollution, heat island effects		Municipality, residents, farmers, businesses, insurance companies (indirectly)	
5. KEY ACTIVITIES		2. VALUE PROPOSITION (from 2020 to 2040)		10. CUSTOMER SEGMENTS	
Bioswales Green roofs Open Vegetated Retention Basins Parking with permeable pavement Rain gardens		2A. Primary service and value	2B. Secondary service and value	10A. Direct Beneficiaries	10B. Clients
6. KEY RESOURCES		Protection against runoff risk	Air pollution reduction: value: 1.8-2.2M€ Carbon sequestration: value: 0.2 unit	Residents of the Lez Basin, Farmers, Businesses	Tax payers, municipalities
-Funding: The Montpellier Municipality perceives a tax of 3 million euros yearly for the prevention of flooding. Need for better information on flooding risk and on co-benefits Department/Region/Europe/Water basin agencies can be involved in NBS funding		Avoided damage costs: 1.30-1.86 M€/yr; Aggregated value 2020-2040: 29M€	Overall estimation of co-benefits evaluated through stated preference survey for 2020-2040: 605M€		10C. Extended Beneficiaries
-Capacity development: training of public workers, awareness					Insurance sector: Insurers are mainly interested in the reduction of flood damages.
-Operation: green infrastructure specialist, engineering companies, gardeners, plants and green biomass, strategic spatial locations...		CLUSTER B. REGULATORY CONTEXT		CLUSTER F. REVENUE STREAMS	
7. KEY PARTNERS		STEP 3. REGULATION		11. REVENUE STREAMS	
-Private developers		Since January 2018, the protection of water ecosystems and the prevention of flooding (GEMAPI) is under the responsibility of Municipalities (runoff risk management, flood zone definition).		Co-benefits generated,, which are mainly public good should leverage investment from municipalities/state	
-Municipality and State (impose the rules on urban runoff management and develop green infrastructure projects)		CLUSTER E. SUPPLY-DEMAND INTERACTIONS		12. FUNDING	
-Local residents: lobby to support implementation.		13. CUSTOMER RELATIONSHIPS		12A. Tariffs Water tariffs paid by consumers indirectly fund deproofing actions implemented by Water Agencies.	
-Specialized engineering and bio-architecture companies who can technically implement these solutions		If implementors are the public sector: automated via website communications, or co-development via public participation.		12B. Taxes The GEMAPI tax in addition to local tax	
CLUSTER D. COST STRUCTURE		If implementors are private entities: direct through contract with payers, community if the solution is implemented by a community (i.e. of neighbours).		12C. Transfers The Barnier Fund (financed by a 1.4% contribution from all insurance policies), other funds	
8A. LIFE CYCLE COSTS		14. CHANNELS		12D. Private investment: Private owners through investment in water retention and infiltration measures to meet the municipal standards.	
Construction and maintenance costs for green infrastructures		Municipality website, formal letters, public participation, community meetings, information sessions/workshops,...		The insurance sector recently considered voluntary contributions	
Actualized cost (2020-2040) without opportunity cost: 92-148M€		CLUSTER H. IMPACT			
8B. OPPORTUNITY COSTS		15. KPIS			
Land cost for the land occupied by green infrastructure that cannot be used for other more profitable use.		Surface of green infrastructure implemented in the basin (m²)		Health impact in terms of reduced mortality and morbidity (Number of death avoided/yr, Number Carbon sequestration (T of C/Yr)	
Actualized cost (2020-2040): 239-396M€		Reduction of hazard in terms of damage avoided (€/yr) and number of people exposed (Number of people in flooding areas)			
		Reduction of air pollutant for NO2, PPM10, PPM2.5, SO2 and O3 (T/yr)			

Table 1: The NAS canvas is applied here step by step to the Lez demo as an example of NAS strategy to mitigate flood risk at the small catchment scale.



4.4 *An Insurer's Challenge: Using insurance schemes to push NBS & DRR*

Understanding the issue

Despite the insurance industry's strong understanding of the risks posed by extreme weather events (otherwise known as natural hazards), a direct link between insurers and prevention policy rarely exists. The European insurance industry has a great number of opportunities to contribute to climate change adaptation (CCA) and disaster risk reduction (DRR), however, these opportunities are greatly influenced by their national context and the set of regulations that the industry operates in.

For examples, countries with voluntary insurance schemes with risk-based premiums must decide how to consider collective protective measures in the evaluation, and whether the alignment of terms and conditions with decreased exposure is different than individual measures. Countries with solidarity schemes (like e.g. France and Spain), alternatively must consider whether moral hazard and risk adverse selection could weaken the long term sustainability of the scheme, even if the very essence of the scheme is flat-premium and the mutualization of risks.

Each and every insurance scheme has a window of opportunity to enhance preparedness and post disaster relief. The development of research and development projects assessing climate risk exposure is required for innovation in the insurance businesses. The insurance industry has the tools, and the catastrophe loss risk models to assess hazards and NBS (to which we have now added Eco:actuary explained earlier). It could promote activity for CCA, data collection, sharing expertise, participate in loss prevention policy and building awareness (French Insurance Federation 2016).

For countries with a high protection gap, the issue will be to consistently understand risk and the role of NBS in risk reduction. This is very important if we keep in mind that current at-risk areas which are currently uninsurable could become, insurable at an affordable price in the future through the implementation of protective measures. The implementation of NBS as preventative measures may help also to expand insurance markets by providing coverage to those who have been priced out of the market or who are no longer insurable due to overwhelming risk.

Learning across Europe

A key barrier in the effective engagement of the insurance sector in eco-DRR is a lack of knowledge of how NBS could reduce the impacts of natural hazards and how these hazards will evolve as a result of climate change. Both commercial and in-house catastrophe risk models must be able to integrate modelling of NBS as preventative measures, as well as expand their



risk horizon to model the effects of climate change over time. These learnings should come from direct investments into internal research, as well as partnerships with expert institutions through demonstration projects and the sharing of data sets – promoting the exchange of knowledge between academia, industry and government.

The French Barnier Fund is lauded as one of the best examples of the insurance sector directly engaged with risk prevention. It is supported by both French Law and the Insurance Code. The Fund supports research and implementation activities through a 12% levy on insurance premiums. Implementation activities include structural preventative measures and also different measures such as amiable land acquisition and targeted communication to raise risk awareness (Figure 2 offers more information on how funding can be used). These alternative prevention measures make room for NBS through alternative land use management and by supporting the engagement of citizens in prevention planning.

The Barnier Fund also creates financial incentives for local stakeholders to implement Risk Prevention Plans (RPP), indeed the mechanism is designed to modulate deductibles according to the number of natural disasters (all risks and droughts) that strike a community without (RPP). In Denmark, the similar mechanism is in place with a deductible modulation which is possible in the case of storm surge (figure 3). While Barnier wears a gold star for its direct integration of insurance with prevention, there are several examples where indirect linkages can also foster better prevention. The insurance sector in Norway is using incidental costs from urban flooding as a driver for municipalities to take greater responsibility for damage prevention through the maintenance of water infrastructure and sewers. Following a heavy precipitation event, insurance companies look at the main cause of the hazard to declare if the damage was unavoidable as a result of an extreme event or if it was due to insufficient maintenance of the infrastructure. If it is believed the damage is due to insufficient infrastructure the bill for damages will be sent to the municipality. Municipalities and cities are responsible for the maintenance of water and sewer infrastructure and must ensure it is in good working order for day to day weather.

The (re)insurance industry has a role to play through supporting local level decision making with relevant data. Models such as the economic assessment described in section 2 rely on sound data, data that (re)insurers collect as part of their daily operations and that can support local decision making. To make the case for NBS strong evidence is required. Collaborative assessments by (re)insurers and planners can employ (avoided) damage assessments, cost-benefit analysis and multi-criteria analysis of co-benefits to weigh options for NBS as preventative measures. The justification of disaster risk reduction measures is necessary to demonstrate that the benefits to the community will be greater than the implementation, life cycle costs and maintenance costs.



For whom? <i>The beneficiaries</i>	Local authorities				Natural or legal person (individual or companies with less than 20 employees)	
For what? <i>The studies, works and subsidized acquisitions</i>	friendly land acquisition of property exposed to a major natural risk	friendly land acquisition of property damaged by a natural disaster	studies, works and preventive equipment	recognition and filling of underground cavities	studies and works imposed by a RPP	
Level of financing? <i>Variable rates ¹</i>	100% max.	€240 000/land unit max.	Between 25% and 50% max.	30% max.	Private house 40% max.	Companies 20% max.
Risks involved?	landslides; subsidence due to an underground cavity or due to a natural or a man-made that does not result from the past or ongoing mining operation; torrential rains or fast rise;	any risk likely to cause a disaster that may be the subject of a declaration of "natural disaster"	any major natural hazards	risks of land subsidence due to underground cavities or hinges due to natural or human origin and not resulting from the past or ongoing mining exploitation	any risk covered by a RPP	
Which conditions? <i>Depending on the nature of the risks</i>	serious threat to human lives acquisition expenses of the property lower than the average cost of safeguarding and population protection property covered by a "multi-risk home insurance" including the guarantee against natural disasters	assets covered by an insurance contract including the guarantee against the effects of natural disasters and their base lands (for companies with less than 20 employees) damaged properties to more than half of their initial value excluding risk and indemnified under the natural disaster guarantee	communities covered by a prescribed RPP or approved assets covered by a "multi-risk home insurance" if the envisaged operations concern directly property exposed to natural hazards	reconnaissance operation: proven dangers for buildings and human lives filling operations: serious threat to human lives and cost of works less than the cost of expropriation compensation	assets covered by a "multi-risk home insurance" and existing at the date of approval of the RPP if the envisaged operations concern directly property exposed to natural hazards	

¹/According to eligible transaction costs

References: Based on Ministry of Environment 2016 & www.mrn.asso.fr - IRSTEA, Nov. 2017

Figure 2: Subsidies from the Barnier Fund to implement RPP's vulnerability reduction measures

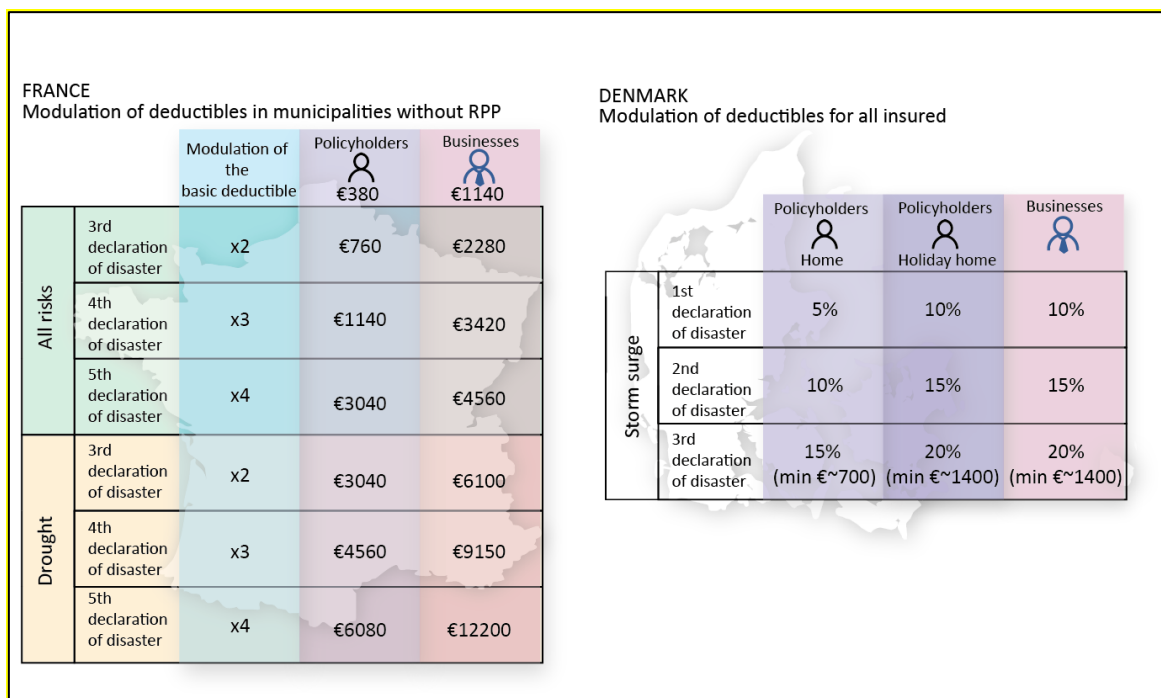


Figure 3: Example of deductible modulation, in France if the community has not implemented a Risk Prevention Plans and in Denmark according to the exposure to storm surge

In the Netherlands or in UK, the agreement is that the government takes the responsibility for preventive measures implementation and maintenance. Then, the insurance industry agrees to supports flood insurance. Flood Re was designed to incentivise disaster risk reduction by UK insurers and targets only homes built up to 2008, and to de-incentivize new building in flood zones. The agreement is that the insurance industry supports Flood Re if the government maintain its commitments to fund flood preventative measures.

Insuring nature is another novel product that has entered the scene over the past few years with growing interest in popularity from reinsurers, governments and conservation activists. One such example is that of Mexico's coral reef insurance – a parametric insurance product that will release up to USD \$3.8 million in funds to quickly restore the Mesoamerican Reef from hurricane damage. Coral reefs help maintain the local tourism industry by reducing the damaging effects hurricanes and storms can have on beaches, as such funds for the trust backing the insurance policy will be drawn directly from the tourism sector and government sources. This is an excellent example of the government and private sector working hand in hand to invest in eco-DRR through insurance tools.



5 DEMO Case Stories: Tales from Three Catchments

One of the key strengths of the NAIAD project was its ability to test the assessment methodologies and integration tools it has developed in real life scenarios through 9 demonstration projects located across Europe. Here we first compare findings from two demonstration sites of similar size and addressing similar flood risk issues, but that have faced strikingly different conditions for implementation. In one case, the implementation environment made it extremely challenging for an NBS to even be considered as option. In the other case, there are multiple pathways to implementation created by with new and existing measures taken by the government that enable investments in NBS. Finally, we look at the Lower Danube in Romania to highlight a different challenge: public perception of flood risks are low and not in line with actual risk levels faced. This requires investment in risk reduction and finding ways to enable public support for NBS or measures taken to achieve this.

Glinščica, Slovenia – Nature's has solutions to reduce risk but politics are a different problem

Through a series of interviews and stakeholder engagement processes in the Glinščica catchment looking specifically at the adoption of NBS for flood risk management, the NAIAD team unearthed a broader issue of failed transition to adaptive integrated water management in Slovenia. Godden (2011) points out that barriers to implementation of new technologies, such as NBS, are often socio-institutional rather than technical. Common challenges include a lack of coordination between institutions, unclear roles and responsibilities between parties, low levels of community engagement, and little or no monitoring and evaluation. For the Glinščica catchment specifically, barriers to the adoption of NBS for flood risk management included: a high degree of scepticism from decision makers to engage with local research projects; fragmented practices in water management; institutional knowledge gaps; low interagency cooperation; weak participatory processes and, an acute lack of enforcement and accountability. While legislation has greatly advanced quickly in recent years it is not being fully implemented.

Once the participating stakeholders developed and agreed on the best future strategy for the Glinščica catchment that included an NBS, another barrier was identified: land ownership. While this is a broader issue connected to the struggles of the EU Common Agricultural Policy, the implementing institutions faced the opposition from land owners (mostly farmers) as the main barrier preventing specifically the implementation of NBS measures (which usually require more space than grey solutions). The Ministry for agriculture, forestry and food, expressed their opposition to using agricultural land for water risk management. On the other hand, the opposition from farmers was not absolute and was impacted by past bad experience with governmental institutions that usually fail to understand and accommodate their requirements.



One farmer, for example, expressed his concern with the governmental institutions that prohibited him from building small retention reservoirs on several of his fields, a practice that he learned from German colleagues was supported by the German government. Building a more enabling environment for NBS uptake in Slovenia will take time, effort and resources. Several participating stakeholders noted that top-down guidance and pressure from the EU through the changes in its own policy, regulations and enforcement is a critical lever needed to push more integrated and adaptive water management at large, and considerations of NBS as a result of such circumstances.

Brague, France – A strong enabling environment for NBS still requires political will

The Brague DEMO, as Glinščica, is a catchment of intermediate size (5-200 km²) located in south France along the Mediterranean coast. Similar flash flood problems are experienced but the institutional context is very different. Several laws created national funds funded by taxes on insurance premiums to finance flood protection measures and by water bills to finance river restoration measures. A recent law, GEMAPI, closed the loop by making it mandatory for any works performed in a river to address risk reduction and environmental restoration. It also allows river managers to raise a local tax, up to 40€/person/year, to finance it. NBS are *per se* measures consistent with this policy context but are not yet mainstreamed.

Lack of confidence regarding the flood reduction capacity of NBS is a key barrier to their implementation. River managers are advised at a daily basis by civil engineers working from consulting companies. Their expertise on computing the physical effects of large civil engineering structures on flood processes are ancient and solid. This experience is however much lower regarding NBS effects. Evidence of significant cumulated flood reduction effect of NBS as well as capacity building for design engineers to compute and design NBS with targeted risk reduction objective are needed.

Another barrier is related to lack of decision maker commitment for ambitious NBS projects. In the Brague River, urban sprawling during the 1980s and 1990s confined the river channel in an excessively narrow stripe unable to convey extreme flows. The proposed NBS strategy, namely small natural retention areas in the upper basin and giving room to the river in the lowlands, requires demolishing about 50 houses. Even though these houses have experienced repeated flood events over the last decade and most people are willing to leave, decision makers are reluctant to launch large-scale and ambitious expropriations operations to achieve a consistent vision of the river corridor for the next 50 years. Bringing significant improvements in both river quality and flood risk is feasible but require strong political willingness to launch a long-term integrated plan that will start by a difficult phase of real estate acquisition.

Lower Danube, Romania: What to do if the customer is not right (about their risk perception)?



The research performed in the Lower Danube demo during NAIAD aimed at understanding the role of natural assurance schemes in complex natural, economic and social contexts. The vulnerability to water-related hazards in the Demo region was mapped and two scenarios were analyzed focused on the total flooding (optimistic planning scenario) or partial flooding (realistic planning scenario) of an enclosure. The NBS risk mitigation solution (a restored pond) would protect communities up- and downstream in the identified location while supporting the diversification of economic activities and sustainable development for the local community (fish farming and eco-tourism). The application of a model developed by CCR provided estimates of the amount of damages related to destroyed and affected dwellings and an average cost per claim. To increase the relevance and the potential for replicable results, the large scale demo approach was complemented with a focus on the valuation of a specific NBS along with other soft-institutional measures to allow assessment of effectiveness, based on a combined bottom-up interest of communities for diversification of economic activities and a top-down concern for reducing the pressure on the grey infrastructure for flood protection by means of a cascade system of green solutions. The approach was synthesized in a business model and a proposal for a financing framework for water security that, with further elaboration, could be used for upscaling the approach within a strategy for recreating the green corridor along the Danube.

The research in the Lower Danube demo included an open dialogue with the local insurance sector. The increased frequency and intensity of natural disasters and the increasing value of both private and public property will result in higher risk exposure. The sector is recognizing the urgency for action (including for prevention) but, remains client oriented. It prioritizes ensuring accuracy of forecasting and risk quantification methods, but not prevention or mitigation mechanisms. The Romanian insurance sector is additionally coping with the relatively recent incorporation of insurance concepts in citizens' financial education requiring focus towards raising awareness and building trust. At the same time different regulatory obligations (e.g. GDPR, professional accreditations, etc.) often result in prioritizing the core business and leaving little capacity for actively seeking new business models.

The low level of public risk perception is a recognized barrier towards sector involvement in strategic actions for mitigation of water related risks at the national level. A study conducted by UNSAR³ (2018) showed that 90% of the Romanians perceive that the climate is changing and 71% are interested in property insurance. Yet, most do not consider floods and droughts as major risks. Partnership with scientists and knowledge providers along with functionality of public-private-partnerships at local level are essential for the identification and implementation of resilience measures in which the sector can get involved or can contribute to. There is a clear acceptance on the advantages for sharing actuarial data and mutualisation of risk levels,

³ The National Association of Insurance and Reinsurance Companies in Romania



however a successful approach needs the support from the financial supervisory authority regulating the market to create and manage the needed instruments at national level. With a concerted approach the sector can contribute to prioritization of green solutions by adapted premiums and underwriting criteria. Incorporating climate change in different sector policies (such as agriculture, territorial development, water, health, education, etc.) can impact in the same direction. The government is the key player here as they are the ones that ultimately have responsibilities to reduce hazards, exposure and vulnerability, influencing policies in different sectors and utilize legislative power via central and local authorities to implement resilience building measures.

6 Conclusions

This policy brief has highlighted learnings from NAIAD to address, innovate and learn to overcome challenges to the implementation of NBS to reduce water-related risks. It showed how insurance schemes can both impact and support NBS for risk prevention and mitigation and provided insights from demonstration projects on factors that can enable or dissuade their uptake.

While there is great enthusiasm and support at an EU level to promote NBS; scaling investment still requires enhanced coordination, capacity, and confidence among public authorities that would be primarily responsible for accessing their financing and overseeing their implementation. The demonstration cases also show that the implementation landscape across Europe is diverse. In many countries prioritized actions from the EU may still be required to ensure water-risks are recognized appropriately by governments and citizens, and that NBS are viable options for risk reduction. There are several specific policy mechanisms developed in member states that can be considered for application in other countries or even at EU level. The Barnier Fund, for example, which supports implementation activities for DRR by the national insurance scheme, has proven an effective example in France. Together with GEMAPI Law in France, which allows river basin authorities to authorize a tax to finance actions for risk reduction and environmental protection/restoration, there is a strong enabling environment for viable NBS to be implemented.

NAIAD has developed tools that support evaluation of risk reduction potential provided by a proposed NBS or GI, as well as tested of integrated Cost-Benefit Analysis methodologies in several cases. These have shown NBS outperforming grey infrastructure alternatives, but also found that the DRR benefits provided were not able to be conclusively assessed as outweighing the cost of the intervention on their own. Thus, NBS aiming at solely reducing water risks cannot be assumed to be economically efficient. Indeed, NBS often appear to be economically efficient



particularly when all the benefits generated are considered. This requires strategies to translate multiple co-benefits into revenue flows that can be used for project funding. In many cases, it will also involve adapting regulations and procedures to apply public funding to NBS, as different financing bodies may be willing to pay for different types of co-benefits provided.

Finally, there are clear trends of increasing willingness to issue debt financing to invest in NBS or GI projects, through e.g. green bonds as part of or in complement to green infrastructure and climate adaptation strategies. To meet this opportunity, NAIAD provided three innovations to support improved proposals for NBS as viable investment projects. The Eco:actuary web support tool and accompanying investment planner and //Smart river tools, *Handbook for the implementation of Ecosystem based Adaptation* can be used to support proponents of NBS to create a more structured project plans and implementation strategies. *The NAS Business Canvas* can be applied to any NBS project or strategy in order to identify the most suitable business model for the case. Each can make it easier to engage with public authorities, collectivities and private investors into further project preparation. These tools can be applied, refined and promoted to accelerate uptake of NBS across Europe.

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About the NAIAD Project

‘NAIAD’ (Nature Insurance Value – Assessment and Demonstration) is an advanced, first of a 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 drought) by developing and testing - with key insurers and municipalities - the concepts, tools, applications and instruments necessary for its mainstreaming.