NATURANCE

Nature for insurance,
insurance for nature

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Acronyms

Climate Change Stress Test Directive (CCSD)

Community Rating System (CRS)

Disaster Risk Resilience (DRR)

Dynamic Integrated Flood Insurance (DIFI)

Equality, Diversity, and Inclusion (EDI)

European Union (EU)

Green Infrastructure (GI)

Knowledge Network (KN)

International Institute for Applied Systems Analysis (IIASA)

Innovation labs (ILs)

International Union for Conservation of Nature (IUCN)

London School of Economics (LSE)

Nature-based Solutions (NbS)

National Flood Insurance Program (NFIP)

Natural Flood Management (NFM)

Nature-related Financial Disclosures (TNFD)

Organisation for Economic Co-operation and Development (OECD)

UN Capital Development Fund (UNCDF)

Vrije University Amsterdam, Institute for Environmental Studies (VU-IVM)

Wildfire Insurance Innovation Lab (WIIL)

Wildfire Risk Management (WFRM)

Willis Towers Watson (WTW)

Zurich Flood Resilience Alliance (ZFRA)

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Executive Summary

NATURANCE is a Coordination and Supporting Action (CSA) established to evaluate the feasibility and performance of solutions that integrate disaster risk financing and investments with nature-based solutions (NbS). The project operates through three cohorts of three innovation labs, involving insurers and brokers, catastrophe modelers, NbS practitioners and advocates, and local and regional governments or action groups. These labs explore the feasibility and potential of these solutions in real-world contexts, identify and test shared design principles, and explore pathways to implementation.

This report summarizes the first cohort of Innovation Labs, focusing on three key areas:

- **Investing in Natural Flood Management in Urban Areas in the UK** (led by LSE): This lab aimed to co-develop business cases with relevant stakeholders to enable insurers to unlock both direct and indirect investments in natural flood management (NFM) in urban areas across the UK. As climate change accelerates, urban areas face increasing risks from coastal, surface water, and river flooding, which pose significant economic threats through direct property damage and indirect impacts like reduced access to insurance and mortgages. The lab brought together insurers, NFM experts, local councils, and other stakeholders to identify mechanisms that facilitate investment in NFM, which can mitigate urban flood risks and provide numerous ecosystem services and co-benefits despite the costs associated with implementation and maintenance.
- **Methods to Quantify Flood Risk Reduction and Co-Benefits of NbS in the Netherlands** (led by VU-IVM): This lab focused on co-designing improved methods for assessing the risk reduction and co-benefits of Nature-Based Solutions (NbS) for flood risk management in Limburg, Netherlands. It involved stakeholders such as Dutch insurers and local governments to refine methods that identify and value the benefits of NbS, particularly highlighted by the severe flooding in Limburg, Germany, and Belgium in July 2021. The aim was to inform sustainable finance mechanisms for NbS and derive general lessons applicable internationally.
- **Harnessing Insurance to Promote Nature-Based Solutions for Wildfire Risk Management** (led by IIASA): In collaboration with the Firelogue-NATURANCE project, this lab explored how insurance can promote NbS for wildfire risk management (WFRM). It facilitated discussions among insurers, risk managers, ecologists, and other stakeholders to develop innovative insurance products that encourage NbS adoption. The lab also examined how insurance companies can support local communities and national forest agencies in managing wildfire risks through NbS. This lab, which included interactive exercises, motivated a follow-up session in Solsona, Spain, to further explore policy options and business cases for NbS in WFRM.

Each Innovation Lab was structured to define a problem, canvas solutions, and discuss ideas among a group. The process involved defining and exploring the problem, identifying

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potential solutions or innovations, and developing a prototype business case. This business case was then critically stress-tested and questioned to identify potential knowledge gaps and barriers to implementation. The outcomes of this process were summarized in a scorecard-type report and disseminated to the identified audiences. The scorecard consisted of four sections: (1) Problem statement, current baseline, and innovation; (2) Implementation and execution; (3) Financing; and (4) Impact.

Labs were attended by representatives from the knowledge network, who explored natural flood management, flood risk reduction, and wildfire risk management with a focus on Nature-based Solutions (NbS) in terms of risk transfer, investment, or advisory. The structure of the report provides the same overall information for each lab, including an overview of each Innovation Lab from round I, with sections on introduction and purpose, outcomes and results, and reflection and conclusion. This effort is an interactive process, and the findings from this round will inform future rounds of Innovation Labs and scorecard publications on each business case (including round II in month 30 and round III in month 39). Notably, since this initial round was exploratory in nature, only one Innovation Lab produced a scorecard in this round, while the others opted to do so in future rounds.

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1 Introduction

1.1 Details of the Innovation Lab

Innovation labs (ILs) are safe spaces that offer a collaborative environment where different agents are joined together for the purpose of innovating and generating new solutions (Arrighi et al. 2016). The NATURANCE ILs bring together many different types of actors and knowledge, fostering experimentation and experiential social learning (Koelle et al. 2019). The format gives participants the freedom to challenge dominant or business-as-usual approaches, and to innovate new pathways for societal transformation. Key to their success is how the ILs are facilitated and how different voices can be heard (Koelle et al. 2019, Reed & Abernethy 2018). In line with commonly agreed practices for ILs, the management structure of the NATURANCE hubs follow the principles of good governance, reflecting diversity in the composition of the partners and ensuring an open and high-quality decision-making process.

The IL approach is based on the design thinking process, which has its roots in product development, but is increasingly used in the public sector e.g. to innovate policymaking (Mintrom & Luetjens 2016). Design thinking starts with the observation of the status quo followed by the exploration of the challenge. During the IL, the problem is defined, potential solutions are canvased and discussed with the group. The definition and exploration of the problem in combination with potential solutions or innovations are used to develop a prototype business case, which is then critically stress tested and questioned to identify potential knowledge gaps and barriers for implementation. The outcomes of this process can be reported in a scorecard-type summary and disseminated to the identified audiences.

Types of innovations (adapted from UNICEF, 2012)
Innovation in Programmes: Using new technology and ideas to serve vulnerable regions that would benefit from NbS.
Innovation in Products: Creating processes that support the efficient and transparent creation, adoption or uptake of NbS insurance products. These process innovations have a strong equity focus, ensuring that process is driven by local needs.
Innovation in Processes: Increasing efficiencies in difficult economic environments. Improving the ability to target resources to monitor and manage results.
Innovation in Partnerships: New collaborations with donors, other insurance and finance stakeholders, national and local governments, civil society and the private sector.

The business case can be a short 1–2-page summary following the structure of the scorecard. While the scorecard should be seen as a guide for how to structure the outcomes of the IL, the aim should NOT be to optimize the solution for a high overall score. Instead, all participants should work together to agree on an innovative solution that best represents the view of the IL on how the outlined problem should be approached and solved. The testing and finalising of the solution can all be done in one meeting or workshop or through an

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iterative approach over one or two additional meetings. Based on the outcomes of the third meeting and in agreement with all participants, the NATURANCE consortium lead can organise additional meetings.

1.2 Lab organisation

It is intended that three rounds of three ILs will be facilitated over the course of the NATURANCE project, i.e. nine ILs in total. For each round, as a first step, representatives of the knowledge network (KN) interested in participating in an IL collaboratively explore potential themes for the IL. The range of potential themes is kept deliberately broad to allow the KN representatives to shape their own IL rather than follow a prescriptive top-down approach. Experts from the NATURANCE consortium can help to steer and facilitate the process to find a theme for the IL. The ILs should cover one or more of the following three areas:

- NbS in risk transfer
- NbS in investment
- NbS in advisory

Deciding on NATURANCE consortium member to lead the Innovation Lab

The ILs are run under the leadership of one NATURANCE consortium member (LSE). Each consortium member will lead at least one IL over the course of the NATURANCE project. Once the KN representatives have agreed on a theme for their IL, they decide which NATURANCE consortium member is best suited to lead their IL. Not every IL will have the same criteria to decide which consortium member is most suitable, but factors that can be considered are the respective areas of expertise e.g. through their academic work, access to a helpful network, existing collaborations and/or the leadership skills of the consortium member. Both the NATURANCE consortium members and the KN representatives are regularly updated about the formation of ILs, so both sides can actively approach each other and find the right match between IL theme and consortium lead.

Box 1: Example template for an IL statement
We suggest focusing this innovation lab around **[Specific subject area]** – and specifically building support for **[more specificity]** – a project that is being initiated by **[linked to for example a previous activity or identified challenge]** to **[impact goes here]**.

Selecting participants for the Innovation Lab

Once the KN representatives have agreed on a theme for their IL and established a working relationship with the NATURANCE consortium member leading the IL, participants for the IL can be selected. ILs are intended to have between 5-10 participants, but the exact number can vary depending on the specific topic and need for expertise. The selection or nomination of participants should be guided by the following questions:

- What expertise do we need and what expertise can we provide?
- Which sectors and stakeholders should be represented?

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In addition to the required expertise and representation of all relevant sectors, the selection should be informed by equality, diversity, and inclusion (EDI) criteria including gender, race, disability, and age. During the selection process, EDI criteria should be embraced by actively encouraging underrepresented members to join the IL.

Format and time frame

The group participating in the IL needs to agree on the format and time frame of the IL. ILs can last between 1 and 9 months but should not exceed the 9 months' time frame. Over the course of the IL a series of workshops, small group discussions or roundtable discussions are organised. Following those workshops or group discussions, participants follow up on agreed upon action items. The number of meetings and preparation time between the meetings is at the discretion of the participants of the IL. The format of the meetings also depends on whether the meetings are online, in-person or in a hybrid format, with full day meetings being easier to facilitate in person due to stronger fatigue effects during long online meetings.

Logistics and tools

When participants of the IL have agreed to a format and time frame, they need to decide on the cadence of individual meetings or workshops that should be held as part of the IL. Depending on the location of the participants, budget and willingness to travel, the IL can be organised as a series of online, in-person or hybrid events. In case of an in-person or hybrid event, a suitable venue needs to be selected and booked. ILs can also be combined or integrated into existing events such as conferences, other meetings or workshops.

Setting expectations

While the key problem statement that will be addressed in the IL is defined in detail during the first session of the IL, setting the overall expectations and the outcomes to aim for, given the theme, format and timeframe of the IL, helps to steer the group while running the IL. This should be done by the NATURANCE consortium member while preparing to run the IL. The expectations for the IL should be informed by the following questions:

- What is the scope of the challenge being addressed by the IL addresses and what is out of scope?
- Is there any ambiguity in the concepts and terms that will be addressed in the IL, which need to be clarified with the participants in the first session?
- Are there any risks that could lead to an unsuccessful outcome of the IL; how can these risks be managed?

1.3 Reporting and disseminating the outcomes

After the completion of the IL, the outcomes of the IL need to be summarized and reported. For that LSE, together with the NATURANCE consortium member leading the IL, will use the business case summary and other documentation or minutes created during the IL to

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summarise and score the suggested solution. Together with the results of the other two ILs that have been running in parallel, the outcomes will be published in a synthesis report.

The outcomes of the IL could be summarised using the scorecard summary. The scorecard consists of four sections: (1) **Problem statement, current baseline & innovation**, (2) **Implementation & execution**, (3) **Financing**, and (4) **Impact**.

Each section consists of three core questions that should be answered using the material and documentation from the IL in combination with the inputs from the NATURANCE consortium lead. Each question is scored from 1 (lowest) to 5 (highest). In case a question cannot be answered or assessed based on the outcomes of the IL, the question is scored with a 0. This means each of the four sections can reach a maximum of 15 points, resulting in a maximum total score of 60 for all four sections.

Scorecard Summary in First Round of Innovation Labs

The scorecard summary concept began as an experiment in how the outcomes of the IL might be summarised. For the first round of ILs, some ILs did not use the scorecard summary process to disseminate their findings. ILs may produce scorecard summaries at a later stage as the research and dissemination for the IL continues. For this first round, VU-IVM produced a scorecard summary, while IIASA and LSE opted to produce a scorecard at a later stage.

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2 First Round of Innovation Labs

2.1 Overall Approach

The call for the first round of innovation lab ideas started in Q1/2023. LSE reached out to consortium members and the KN to propose innovation lab candidates. Due to the early stage of the project and the ongoing work of Work Package 1 on the KN, LSE decided to actively approach consortium partners with more mature ideas for an IL as opposed to partners who may be just starting out. After multiple meetings to discuss and flesh out ideas, IIASA, VU-IVM and LSE took leadership and responded to the call for innovation labs with three distinct focus areas: wildfire (IIASA), NbS as part of the reconstruction process after the 2021 floods in the Netherlands (VU-IVM), and nature-based solutions for urban flooding in the UK (LSE).

All three innovation lab proposals presented their pitches during the first Naturance Webstival on June 14 -15 2023 (each proposal is outlined below). The pitches and innovation lab expo marked the kick-off for the first cohort of innovation labs. After the three pitches, three parallel virtual break-out rooms for each innovation lab were provided as a space to further discuss the idea of the innovation lab and get feedback from the Webstival participants and expert groups. Webstival participants were also able to join one of the breakout rooms to show their interest in the innovation lab, to provide feedback and explore opportunities to collaborate. All three break-out sessions had good participation rates and provided valuable feedback and networking opportunities for the innovation lab leads.

2.2 LSE: Investing in natural flood management in urban areas in the UK

LSE's IL aimed to co-develop business cases with relevant stakeholders that enable insurers to unlock both direct and indirect investments into natural flood management in urban areas in the UK. As climate change accelerates, many areas in the UK can expect an increase in coastal, surface water and river flooding as a result of higher sea levels and more intense rainfall. This poses a major economic threat especially to urban areas through direct damage to properties as well as indirect effects including reduced access to insurance and mortgages and falling property prices in affected areas. Natural flood management can reduce urban flood risk and provide many ecosystem services and other co-benefits but can be costly to implement and maintain. This innovation lab brings together relevant stakeholders including insurers, NFM experts, local councils, and others to identify and develop mechanisms that enable insurers to unlock investment in NFM.

2.3 VU-IVM: Methods to quantify flood risk reduction and co-benefits of NbS in the Netherlands Ethical concerns related to nature-based solutions

VU-IVM's IL aimed to co-design with relevant stakeholders improved methods for assessing the risk reduction and co-benefits of Nature-Based Solutions (NbS) for limiting flood risk in the province of Limburg in the Netherlands. The flooding in Limburg, Germany and Belgium in July 2021 showed the vulnerability of the current system against floods and highlighted

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that flood management should be improved. The innovation lab involved stakeholders such as Dutch insurers and local governments to improve the most relevant methods to identify and value the key benefits of NbS to inform sustainable finance mechanisms for NbS, and aimed to draw general lessons for applying these methods internationally.

2.4 IIASA: Harnessing insurance to promote nature-based solutions for wildfire risk management

Taking place within the Firelogue-NATURANCE collaboration, IIASA's IL explored the role of insurance in promoting NbS for wildfire risk management (WFRM). Participants discussed how insurers can collaborate with risk managers, ecologists, and other stakeholders, to develop innovative insurance products that encourage the use of NbS and explore the ways insurance companies can support local communities, national forest agencies and other policy agents in adopting NbS for managing wildfire risk. The discussion motivated a follow-up Innovation Lab that took place in Solsona, Spain as part of the Horizon Europe Firelogue project's Wildfire Insurance Working Group in collaboration with NATURANCE. Throughout the lab, interactive exercises were used to explore policy options and the business case for implementing NbS for WFRM. The questions the IL aimed to address included:

- What are NbS for WFRM?
- How can insurers promote NbS for wildfire with innovative products and activities.

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3 Innovation Lab 1 - Investing in natural flood management in urban areas in the UK

3.1 Overview

The UK faces growing flooding risks from rivers, coastal surges and rainfall events. In particular during extreme rainfall events, sealed surfaces lead to increased surface water runoff, overwhelming the existing drainage infrastructure, leading to flooding of areas that previously did not experience flooding. Urban areas are particularly at risk, and new property developments can increase the pressure on existing flood risk management approaches.

Nature can play an important role in addressing this trend – for example through nature-based solutions such as natural flood management (levee setbacks, re-meandering of rivers, urban greening, etc) and green infrastructure (GI). However, particularly in urban centres, it may appear difficult to use nature as a risk reduction measure – as there is limited space to have large-scale flood retention. At the same time urban expansion and densification is competing with existing green spaces destroying natural habitats, threatening local biodiversity as well as the functioning of local ecosystems.

Over the course of February-May 2024, LSE's NATURANCE team has convened a small group of experts for an Innovation Lab focused on natural flood risk management in an urban context. During the first stage of the lab we identified benefits and challenges, discussed possible incentives, technological advancements, and regulatory frameworks for funding urban nature-based solutions. Key aspects that came out during the lab sessions:

- trust: does it work?
- equity: who benefits, and where?
- financing: who pays?

The IL looked at this through the lens of local authorities, who are facing many challenges, particularly in the current economic climate where financial resources and funding are significantly constrained. We asked if there are solutions that offer multiple benefits, that help to address flooding, health, nature and insurance questions for urban areas. We identified the newly introduced Biodiversity Net Gain (BNG) legislation as a potential opportunity for enhancing investments in natural urban flood risk management. The BNG legislation came into effect in England from February 2024 and represents a significant shift in planning regulations. The legislation, which is part of the Environment Act, aims to ensure that wildlife habitats are left in a measurably better state after development takes place and, as such, is likely to play a crucial role in restoring and preserving nature. When developers undertake a project, BNG mandates that they must provide a minimum of 10% biodiversity net gain by the end of the development, and the habitat they create or enhance must be maintained for a minimum of 30 years. For LSE's innovation lab, this presents an interesting business case. In the second part of the lab we are therefore exploring with our partners how projects that combine BNG and urban flood risk management could be designed. Our

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objective is to not only deepen the understanding of BNG's potential to enhance urban resilience, but also to mobilize this knowledge into actionable strategies that can be adopted by policymakers, urban planners, and community stakeholders.

This report summarizes the innovation lab approach, key insights and early findings from the process. It should be seen as a preliminary summary of the innovation lab process. As the final phase is still ongoing, with participants still engaged in developing the business case for insurance and BNG, there will be a final draft prepared later this year.

3.2 Introduction and purpose of the lab

The challenge

Urban infrastructure in the UK is not designed to withstand the increasing frequency and intensity of extreme weather events resulting from climate change. At the same time, urban expansion and densification is competing with existing green spaces, destroying natural habitats, threatening local biodiversity as well as the functioning of local ecosystems.

The following examples illustrate the multifaceted issues facing urban infrastructure in the UK and the strategies being implemented to mitigate these impacts and enhance sustainability. (The latter example, which refers to increased urban temperatures, is included for broader illustration of the challenges facing UK urban infrastructure, but is not the focus of the IL.)

Flood risks due to increased surface water runoff: Sealed surfaces in urban areas increase surface water runoff during extreme rainfall events, overwhelming existing drainage infrastructure and causing flooding, for example the flash floods that hit southern England in August 2022. The National Infrastructure Commission's 2023 Infrastructure Progress Review highlights significant investments in flood and coastal defenses, and the development of models to improve urban infrastructure resilience against flooding (NIC 2023) (Climate Change Committee 2023b). Furthermore, the Health Effects of Climate Change report discusses the severe impact of flooding on public health, including long-term mental health consequences (UKHSA 2023).

Increased urban temperatures and health impacts: Urban areas experience higher temperatures during heat waves due to heat-absorbing materials like concrete and bricks and insufficient airflow. This leads to health risks for vulnerable populations and decreased productivity for workers. The UK Climate Change Committee's 2023 report emphasizes the need for the NHS (UK’s National Health Service) to include long-term adaptation planning in its Green Plans and to ensure healthcare buildings are adapted to manage overheating and other extreme weather conditions (Climate Change Committee 2023a).

The Role of Nature Based Solutions

The Zurich Flood Resilience Alliance (ZFRA) emphasizes the use of Nature-based Solutions (NbS) as an effective strategy for reducing flood risks and enhancing community resilience. According to the IUCN, “Nature-based Solutions address societal challenges through

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actions to protect, sustainably manage, and restore natural and modified ecosystems, benefiting people and nature at the same time." This can include methods such as restoring wetlands, reforesting areas, and creating green infrastructure like rain gardens and permeable surfaces.

NbS in the form of Natural Flood Management (NFM) and green infrastructure can help to reduce run-off before it enters the urban drainage system, lowering the risk of flooding and sewage overflows as well as helping to avoid expensive retrofitting of existing urban drainage infrastructure. Vegetation helps in cooling urban areas through shading and by absorbing heat. It further helps to stabilize biodiversity with evidence of cases where urban green infrastructure provides benefits to biodiversity comparable to their natural counterparts (Filazzola, Shrestha & MacIvor, 2019).

ZFRA advocates integrating NbS with traditional engineering approaches (often called "grey infrastructure") to form hybrid solutions that are more resilient and cost-effective. For instance, combining green infrastructure with traditional flood barriers can enhance flood protection while providing additional benefits such as improved water quality, biodiversity, and recreational spaces.[1]

Figure 1 ZFRA's Flood Resilience Measurement for Communities (FRMC2)

Compared to NFM in rural areas, more complex land- and property ownership structures as well as vertical layering ranging from underground infrastructure to multi-story buildings requires a different approach to NFM and GI. This not only includes different ecological

[1] Laurien, F., & Svensson, A. (2019). What we've learnt from measuring flood resilience. Flood Resilience Portal. https://floodresilience.net/blogs/what-weve-learnt-from-measuring-flood-resilience/

[2] The Zurich Flood Resilience Alliance's Flood Resilience Measurement for Communities (FRMC) evaluates community resilience by analyzing five types of capital (human, social, physical, natural, and financial) and four resilience properties (robustness, redundancy, resourcefulness, and rapidity).

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approaches but also different ways of financing and implementing these projects. Finding ways to finance NFM and GI can be challenging, especially in cases where the measures will be implemented on private property. Creating financial incentives for property- and landowners can be an efficient way to successfully implement and maintain NbS so they can deliver ecosystem services long-term.

Case studies on NFM and stormwater retention in both rural and urban areas demonstrate how such projects can be successfully financed through both public and private investments. This includes identifying beneficiaries who would pay for specific ecosystem services provided by the NbS (e.g. reduced flood risk through increased water retention). Such a transaction contractually binds NbS providers (i.e. landowners) and NbS beneficiaries (e.g. councils, property owners) over a specific timeframe, ensuring that both parties honour their commitments.

One notable example is the Wyre Catchment Natural Flood Management Project.[3] This project utilizes a blend of public and private finance to implement NFM interventions aimed at reducing flood risk. It involves contractual agreements between landowners (NFM providers) and various stakeholders such as councils and property owners (NFM beneficiaries). These agreements ensure the delivery of ecosystem services like flood risk reduction and carbon sequestration over a specific timeframe. The project uses a mix of grants and loans to cover upfront costs, with ecosystem service payments scheduled over several years to ensure financial viability (Green Finance Institute 2024).

A key challenge in this setup is the risk of unforeseen circumstances forcing either one or both parties to break the contract. Especially on the provider side this might happen in cases where NbS fail to deliver their expected ecosystem services (e.g., because they get damaged in an extreme event or simply because the NbS is not performing as expected). Insurance can help to manage these risks by covering cases where NbS providers cannot deliver the promised ecosystem services. However, there are currently no established insurance products or mechanisms that would de-risk NbS for providers and beneficiaries, for example by ensuring that ecosystem service payments continue to be made in the event that the ecosystem services themselves are not delivered or disrupted during the contractual agreement period.

Another notable example is the development of innovative insurance mechanisms to finance ecosystem restoration / conservation. For example, parametric insurance to protect coral reefs which was originally implemented in Mexico and has since expanded to cover the whole Mesoamerican reef. Such products provide payouts for ecosystem recovery and restoration activities following storm damage, thus maintaining the flood risk reduction benefits. This highlights the potential for developing similar insurance products to support

[3] Green Finance Institute (2022) The Wyre Catchment Natural Flood Management Project https://www.greenfinanceinstitute.com/gfihive/case-studies/the-wyre-river-natural-flood-management-project/

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NbS more broadly (The Nature Conservancy 2024). The insurance and reinsurance industries are beginning to explore their roles in supporting NbS. For example, a study by Marsh McLennan highlighted the potential of using wildfire risk reduction buffers and other natural infrastructure to manage risks and reduce insurance premiums for communities (Marsh McLennan 2021).

There are a number of unresolved issues to develop insurance instruments to protect ecosystems and the services they provide, ranging from a lack of models for risk quantification to unclear regulatory requirements for this type of insurance.

	Barriers	Enablers
Access to finance	High up-front costs, lag before benefits observed Lack of public sector funding, especially for large scale, long term projects Lack of funding to cover NbS operation costs	- Clear Treasury and devolved administration commitment to support high quality NbS and end perverse subsidies that damage nature - Public funds for operation as well as capital costs - Minimum standard baselines for ecosystem protection and sustainable land management, with public funding for public goods to reward those who go further - Channel green recovery funds to high quality NbS
	Lack of private sector funding due to perceived investment risks	- Information hubs for costs and benefits - Government support and public funding to catalyse private funding (i.e. blended finance)
	Short-term business and political decision-making	- Provide secure long term funding mechanisms, e.g. 5-20 years, such as via agri-environment schemes
	Costs and benefits accrue to multiple stakeholders	- Equity and risk sharing agreements - Mechanisms for stacking and bundling different benefits (flood protection, water quality, etc)
	Some types of NbS are not funded across the UK (woodland expansion through natural regeneration, rewilding, agroforestry)	- Wider funding mechanisms that support natural regeneration and rewilding (which can have lower costs than other approaches), agroforestry, etc
	Onerous application system, inappropriate evidence and modelling requirements. Late payment	- Streamlined application systems and evidence requirements; funding for advisors to help applicants. Prompt payment
	Donor channels do not explicitly promote NbS for adaptation (e.g. focus on tree planting for climate mitigation)	- Promotion of NbS for adaptation to donors Criteria to channel donor funding to high quality NbS for climate adaptation
Valuation and policy appraisal	Lack of accepted methodology for valuing NbS comprehensively Over-reliance on CBA	- Alternative valuation methodologies, beyond monetary valuation, to capture and communicate multiple NbS benefits, and how those contribute to policy priorities on social well-being and environmental health
	High discount rates used for project funding appraisals	- Lower discount rates for NbS project appraisal, where appropriate
	Narrow understandings of value, overarching focus on monetisable benefits and GDP economic growth.	- Policy appraisal processes that recognize and account for non-monetisable NbS benefits - Multi-dimensional indicators of social well-being and environmental health for policy and decision-making, moving beyond GDP as the sole indicator of success
Evidence and metrics	Lack of evidence on effectiveness	- Accessible information on NbS effectiveness & cost-effectiveness (Table 5)
	Lack of standard metrics to measure the benefits of NbS makes it difficult for funders to compare investment options	- Standardised metrics for assessing NbS outcomes

Figure 2 Finance Barriers & Enablers for NbS (Source: Nature Based Solutions Initiative 2021)

LSE's Innovation Lab was launched at the Naturance Webstival in June 2023. Over the following six months, stakeholders were mapped to select experts from various sectors. To gain a comprehensive understanding of the current challenges, it was essential to involve all stakeholders who would play a role in the development of a new insurance product. This includes NbS providers and experts, such as Naturance and other UK-based specialists, as well as land and property owners, including property and landowner associations. Additionally, the participation of councils, such as those from Edinburgh and East Suffolk, was crucial. Mortgage lenders like Nationwide, property developers, the Environment Agency's Green Finance Team, insurers such as FloodRe, MMC, and Zurich UK, and technology and model providers like TreesAI, aimed to be represented in this endeavour. After reaching out to experts outlined below, meetings were set up with interested experts. Experts who expressed an interest in contributing to the IL were then selected. After individual meetings with chosen experts, two 1.5 – 2 hour interactive design thinking workshops took place from February-May 2024.

Part I aimed to bring together relevant stakeholders to discuss what specific steps could aid scaling up NFM and GI projects in UK urban areas. In this first workshop, relevant stakeholders were brought together to identify roadblocks and develop innovative solutions

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that can help address some of the challenges identified (see below). Each participant had 5 minutes to present their view and where they see the biggest challenges when it comes to unlocking investments in NbS in urban areas in the UK and how they think insurance could support. The presentations were followed by a 45-minute discussion moderated by Swenja Surminski. The objective of the first workshop was to develop business cases that allow insurers to provide suitable products for de-risking NbS projects in urban areas in the UK.

Part II focused on the new Biodiversity Net Gain regulation and the role of insurance. For this second workshop, experts were sent a list of guiding questions that were to be discussed. The discussions were moderated and guided by Swenja Surminski. The Innovation Lab experts are currently working on a joint policy publication, with a focus on BNG, that will further disseminate learnings from the Innovation Lab.

Organisations / People Involved

Expert	Role and Organisation	Background
Swenja Surminski	LSE Grantham Research Institute on Climate Change and the Environment Managing Director Climate and Sustainability- Marsh McLennan (MMC)	The Grantham Research Institute on Climate Change and the Environment was established by the London School of Economics and Political Science in 2008 to create a world-leading multidisciplinary centre for policy-relevant research and training on climate change and the environment, bringing together international expertise from across LSE and beyond, including on economics, finance, geography, the environment, science, law, international relations, development and political science. Marsh McLennan is the world's leading professional services firm in the areas of risk, strategy and people. MMC helps corporate and public sector leaders navigate an increasingly dynamic environment through four market-leading businesses - Marsh, Guy Carpenter, Mercer and Oliver Wyman. Together, they address the most complex challenges of our time.
Jyotsna (Joy) Khara	LSE	See above
Maeve Sherry	LSE	See above
Anna Beswick	LSE	See above
Expert	Flood Re	Flood Re is a re-insurance scheme that makes flood cover more widely available and affordable as part of your home insurance.

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		Flood Re helps households at the highest risk of flooding. We also provide information about taking action to reduce flood risk. Flood Re will run for 25 years, at which point insurers should be offering policies based on actual risk to property.
Expert	Dark Matter Labs/TreesAi	Trees As Infrastructure (TreesAI) is a cloud-based platform, establishing nature as a critical part of urban infrastructure, alongside bridges, roads and rail, enabling investment, profitability and sustainability. Urban forests regulate a number of ecosystem processes (e.g. water and air quality) and provide tangible and intangible benefits vital for living environments. Trees produce goods such as food and timber; and are deeply connected to our societies and cultures functioning as powerful symbols. TreesAI accounts and values a number of tangible benefits—relating to carbon, water, health, energy, biodiversity and the economy—while acknowledging social and cultural co-benefits.
Expert	Green Finance Institute	GFI is a purpose-driven team of market practitioners with a wealth of experience from across financial services, policy and academia. Led by bankers, they are an 'action tank' with a practical, sector-focused approach to unlocking green investment opportunities.
Expert	Sniffer	Sniffer's vision is of a resilient Scotland where people are working together so that the places where we live, work and play are ready for the challenges and opportunities of a changing climate and environment. Their mission is to be change makers and knowledge brokers for a society with greater resilience to environmental change, in particular climate change. Sniffer manages the Adaptation Scotland programme, and Climate Ready Clyde.

3.3 Outcomes and results

Part I: Exploring the status of urban natural flood risk management and role of insurance in the UK

Part I aimed to bring together relevant stakeholders to discuss how insurance can aid in scaling up natural flood management and green infrastructure projects in UK urban areas. It addressed the challenges hindering investments in these solutions. Experts investigated the insurance industry's role in facilitating investment in NbS and explored innovative financing methods to accelerate the adoption of NbS investments. Additionally, participants

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assessed the necessary regulatory support and subsidy reforms to encourage private and public sector investments in natural ecosystems.

Challenges identified by IL participants

Participants in the workshop acknowledged the benefits of integrated solutions that offer co-benefits for climate resilience but also recognized significant challenges and pushback from decision-makers. The complexity of these projects is perceived as a potential barrier to action, with concerns that the resulting processes could become overly tedious and ultimately undesirable. In England, there is a notable lack of enabling policy for climate resilience and adaptation, contrasting with Scotland's more supportive policy environment. Scotland's efforts to incorporate private sector finance and blended finance into its statutory adaptation program were highlighted, emphasizing the necessity of forming partnerships and developing innovative funding models due to the public sector's financial limitations.

Additionally, there is a significant global funding gap for NbS, which underscores the need for institutional innovation to facilitate public-private collaboration. Participants also highlighted the challenges of interdepartmental coordination within the public sector, emphasizing the difficulty of aligning various departments towards common goals. The fragmented regulatory landscape further complicates the integration of NbS into urban planning, with delays in implementing critical policies, such as Schedule 3 of the 2010 Flood and Water Management Act, exacerbating these challenges.

Concerns about the complexity of implementing integrated solutions with multiple co-benefits were also expressed, noting resistance from decision-makers due to perceived hurdles. The discussion emphasized the need for enabling policies and the capacity to pursue climate resilience and adaptation efforts, particularly through public-private partnerships and blended finance models. Furthermore, skepticism about the predictability and performance of NbS among stakeholders, coupled with a lack of comprehensive, long-term data on their effectiveness, affects their wider adoption. Overcoming this perception barrier is crucial for gaining support and investment in these solutions.

Effective implementation of NbS also requires coordination among a wide range of stakeholders, including local governments, developers, insurers, investors, and communities. The complexity of aligning diverse interests and objectives further complicates project execution, underscoring the need for comprehensive stakeholder engagement and collaboration to achieve successful outcomes.

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Figure 3 Urban NFM- Barriers (Source: FloodRe 2024[4])

Case studies and applications highlighted

The discussions largely focused on enhancing responses to flooding by decentralizing response capabilities. Experts emphasized the need to clarify various questions related to flood response. They discussed the mandatory Schedule 3, which addresses new developments, and expressed curiosity about how other regions handle similar challenges. Examples mentioned included Washington, D.C.'s environmental impact bonds, Philadelphia's incentivization strategies, Amsterdam's rainproof approach, and Copenhagen's cloudburst approach.

The conversation highlighted the necessity of creating a regulatory and incentive infrastructure that supports not only new developments but also the retrofitting of existing infrastructures. Scotland's ongoing effort to draft a National Flood Resilience Strategy was mentioned as an example of policy development, with mandatory requirements potentially being part of the outcome.

Overall, experts underscored the importance of strategic, local planning and regulatory incentives in fostering broader flood resilience efforts.

[4] Slide presented in Innovation Lab in April 2024. Some statements in the slide have gone through updates. The slide will be updated after confirmation

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Case Study
Insights from Glasgow and Edinburgh underscore the potential for innovative partnerships and financial models to advance NbS. Collaborative projects involving technology firms and the development of digital twin models for flood mitigation exemplify the creative approaches being explored. The discussions also touched on the exploration of blended finance models for NBS projects, highlighting the complexities of making these financially viable.
The Role of Regulatory and Financial Mechanisms: Experts also emphasized the need for clear regulatory frameworks and financial mechanisms that can support the development of bankable NbS projects. The Adaptation Scotland Programme (Sniffer) is mentioned as an initiative aimed at fostering an enabling environment for NbS through stakeholder engagement and policy support. The potential for insurance to play a significant role in de-risking NbS investments is discussed, with a call for more innovative financial products and services that recognize the multifaceted value of NBS.

Innovation areas identified

To provide a comprehensive understanding of potential areas for innovation within NbS, experts explored various domains that can significantly contribute to the effectiveness and scalability of these approaches. The following table highlights key areas identified for innovation, each offering unique opportunities to enhance the implementation and impact of NbS in urban flood management. These areas include advancements in financial instruments and models, regulatory reforms, community engagement and equity, as well as digital and technological solutions. The subsequent sections provide detailed insights into these innovative approaches, underscoring their importance and potential to transform urban flood resilience through NbS.

Areas for Innovation	
Financial Instruments and Models	The discussion pointed to the need for developing new financial mechanisms, such as green bonds or insurance products, that recognize the value of NbS co-benefits. These instruments could help de-risk investments and make NbS projects more attractive to financiers.
Regulatory Reforms	Advocacy for regulatory reforms and the establishment of clear standards is critical. This includes resolving ambiguities around risk and liability management and setting guidelines that facilitate NbS integration into urban flood management strategies.
Community Engagement and Equity	Emphasizing the importance of community involvement in NbS projects, from planning to maintenance, to ensure sustainability and equitable access to the benefits. Engaging communities can also enhance social cohesion and foster local stewardship of green spaces.

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Digital and Technological Solutions	Leveraging digital models and technologies, such as agent-based modelling and digital twins, offers a way forward in accurately assessing NbS impacts on urban flooding. These tools can help build a stronger evidence base for NbS effectiveness and inform decision-making. (Agent-based modelling involves computer simulations to study the interactions between people, things, places and time; a digital twin is a virtual representation of an object or system, designed to be an accurate representation.)

Conclusions

Despite the recognized potential of NbS for flood risk management and proven projects such as those in Amsterdam and Copenhagen, their integration into broader risk management, insurance, and investment frameworks faces significant obstacles. The complexity of current policy frameworks and regulatory environments, such as the delays in implementing Schedule 3, impedes the scalability of NbS projects, creating a challenge in aligning public and private financing mechanisms for comprehensive flood resilience strategies.

Furthermore, the absence of standardized, evidence-based models for quantifying the multi-faceted benefits of NbS, including biodiversity enhancement and climate resilience, hampers their valuation and incorporation into investment decisions and insurance models. This situation is exacerbated by the inadequacy of existing biodiversity credit systems, which fail to fully recognize the flood mitigation benefits of NbS, as highlighted in the discussions about the new biodiversity credit requirement in the UK and its lack of integration with flood management objectives.

Moreover, there is a notable gap in embedding NbS within corporate risk governance structures and the broader investment landscape. This gap is evident in the challenges faced by the insurance sector in integrating nature-based flood defenses into their models and the reluctance of institutional investors to commit to NbS projects due to perceived risks and scalability issues. The discussions also emphasized the difficulty of fostering inter-departmental coordination within public sectors for NbS projects, further complicating the creation of investable, large-scale NbS projects that can attract significant private investment.

The overarching problem, therefore, is not just the need for innovative, integrated approaches to bridge the policy, investment, insurance, and implementation gaps for NbS in flood risk management, but also the urgent requirement to develop and adopt cross-sectoral partnerships, financial instruments, and policy reforms. These reforms must aim to standardize the valuation of NbS benefits, clarify the rules for investment and insurance of NbS projects, and enhance the scalability and attractiveness of NbS for both public and

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private sectors, thereby unlocking their full potential in contributing to sustainable and resilient flood management ecosystems.

Part II: Investigating BNG related opportunities for natural urban flood risk management

Building upon the foundational insights gathered during Part I, which underscored the urgent need for innovative approaches to urban flood risk management, Part II shifted the focus towards the practical integration of BNG principles into urban flood risk strategies. The objective is to not only deepen the understanding of BNG's potential to enhance urban resilience but also to mobilize this knowledge into actionable strategies that can be adopted by policymakers, urban planners, and community stakeholders.

The initial focus of Part II was on establishing a broad understanding of BNG principles, their relevance to urban flooding, and the broader benefits they offer to communities and ecosystems. Participants discussed defining BNG within this context, examining supportive policies, exploring the multifaceted benefits of BNG, engaging stakeholders effectively, and establishing metrics for success.

Key Areas of Focus:

- Defining BNG and its application to flood risk management.
- Policy landscape and regulatory support for BNG in urban planning.
- Broader benefits of BNG for urban resilience and sustainability.
- Strategies for stakeholder engagement and coordination.
- Metrics and tools for measuring BNG effectiveness in flood mitigation.

The second phase of Part II explored practical approaches to implementing BNG for flood risk management and is ongoing.

Key Areas of Focus so far:

- Exploring how BNG could be applied in urban flood mitigation and how this could be linked to other innovative BNG approaches (co-benefits).
- What data and technologies would be needed to align BNG and flood risk management?
- Reflecting on emerging financing models and incentives to support BNG projects.
- Addressing barriers to BNG implementation in urban settings: how could these be overcome?
- What is the scope for developing an actionable roadmap for integrating BNG into flood risk management?

Investigating the foundations of BNG in Urban Flood Risk Management

BNG is an environmental policy mechanism that requires developers to ensure their projects result in a net gain in biodiversity. During the discussions, participants noted that while BNG is mandated, its application, particularly in urban contexts, presents significant challenges. These challenges include limited space and difficulties integrating BNG with existing urban infrastructures. The discussion revealed that some participants had only a superficial

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familiarity with BNG, highlighting the need for a deeper understanding and more strategic application in urban planning.

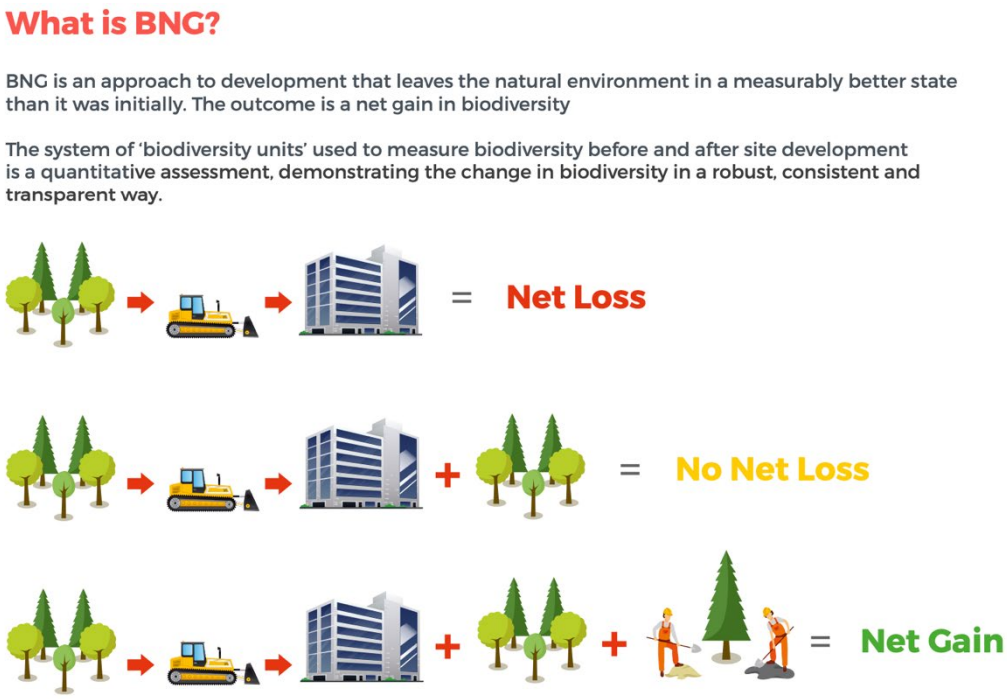

Figure 4 What is Biodiversity Net Gain (Source: WSP, 2023)

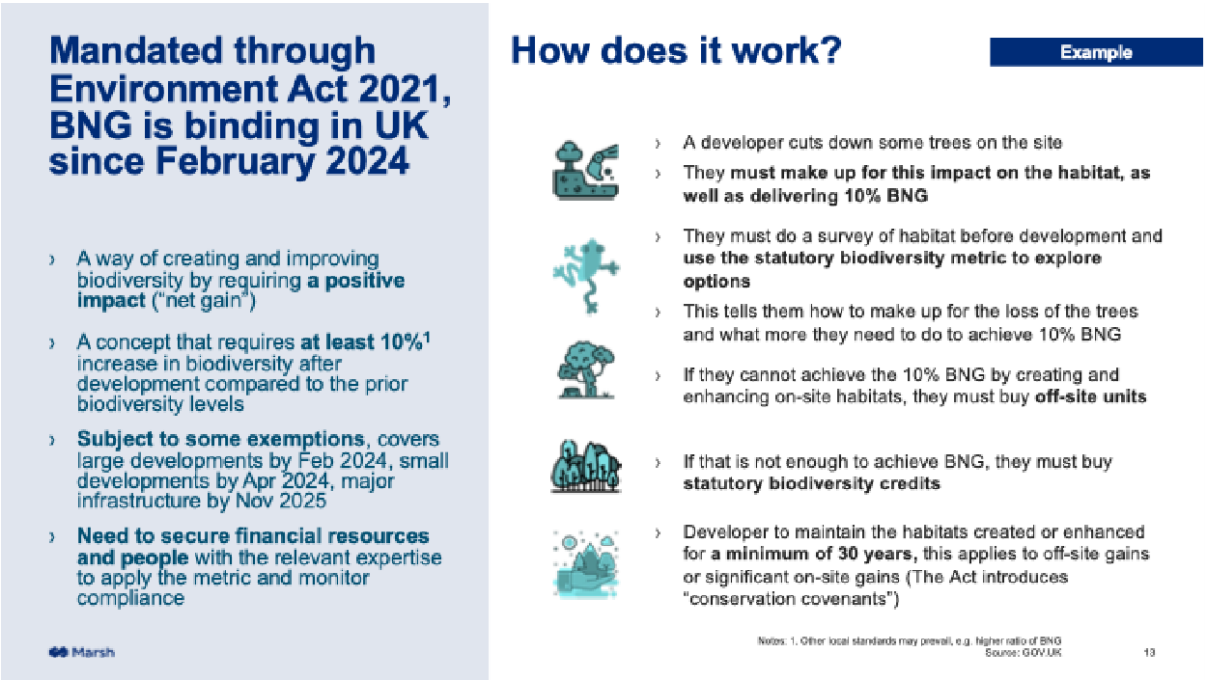

Figure 5 How Does BNG Work? (Source: Marsh 2024)

Implementing BNG in densely populated urban areas poses specific challenges, such as the scarcity of available land for habitat creation or restoration, regulatory complexities, and potential conflicts with other urban development priorities. Workshop participants

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emphasized the necessity for innovative approaches to incorporate BNG within the urban fabric without compromising development goals or ecological outcomes.

Case studies and applications highlighted

Hull: The city of Hull has implemented a BNG initiative aimed at enhancing local biodiversity through development projects. Some key features of this initiative will be mandatory compliance where developers in Hull must achieve a 10% increase in biodiversity using a government-provided metric. This requirement will be fulfilled through on-site biodiversity improvements, creating new habitats off-site, or purchasing habitat credits. The main goal of the BNG initiative is to compensate for habitat losses and improve biodiversity in the area.

In the context of Hull's BNG initiative, the enforcement of the obligation to maintain habitats for 30 years is crucial. Developers must create a management plan detailing how they will manage and maintain the habitat for this period. Regular reporting to authorities and periodic checks ensure compliance. Similar to long-term asset management, payments to third parties for maintenance are made on a rolling basis to ensure performance. Non-compliance can lead to legal action, and the local authority may intervene to deliver the BNG, recovering costs from the developer if necessary (Marsh McLennan 2024).

Case Study: Metropolitan Glasgow Strategic Drainage Partnership (MGSDP)
The MGSDP initiative was highlighted as a successful example of cross-sector collaboration in urban water management. Despite facing challenges such as interagency coordination and funding, MGSDP has implemented several successful projects that align water management with urban development needs, showcasing potential strategies that could be adapted for integrating BNG. Technological and Policy Innovation: The potential of leveraging technology and innovative policies to support the integration of BNG with urban planning and flood risk management was a key discussion point. Digital twins and simulation models were mentioned as tools that could help planners and decision-makers visualize and plan the impacts of green infrastructure on biodiversity and flood management. Leveraging data and technology to improve the planning, implementation, and monitoring of BNG and flood risk management projects is fundamental. This includes developing shared databases of projects, creating digital twins of urban areas to simulate interventions, and using AI and machine learning to optimize project outcomes.

Integration with Flood Risk Management

Opportunities for Integration: The integration of BNG with flood risk management was seen as a promising area to enhance urban resilience. NbS, such as the creation of urban green spaces, parks, wetlands, and the restoration of natural waterways, can contribute to flood mitigation while enhancing urban biodiversity. Such integration could provide multifunctional benefits, improving both the environment and the quality of urban life.

Case Studies and International Examples: Examples from other countries where similar integration has been attempted were discussed. For instance, in France, regulations aim to

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minimize construction on untouched natural sites and focus on redeveloping brownfield sites. Such practices not only preserve natural habitats but also reduce flood risks by avoiding construction in flood-prone areas.

Expanding Technical and Financial Capabilities

There's a strong case for establishing technical assistance programs that can help local authorities and other stakeholders navigate the complexities of integrating BNG with flood risk management. Such programs could offer guidance on blending funding streams, developing technical expertise, and ensuring projects meet both biodiversity and flood mitigation objectives.

Exploring innovative finance mechanisms that can support the dual objectives of BNG and flood risk management is crucial. This could include the creation of green bonds, environmental impact bonds, or even new insurance products designed to support nature-based solutions and their maintenance over time.

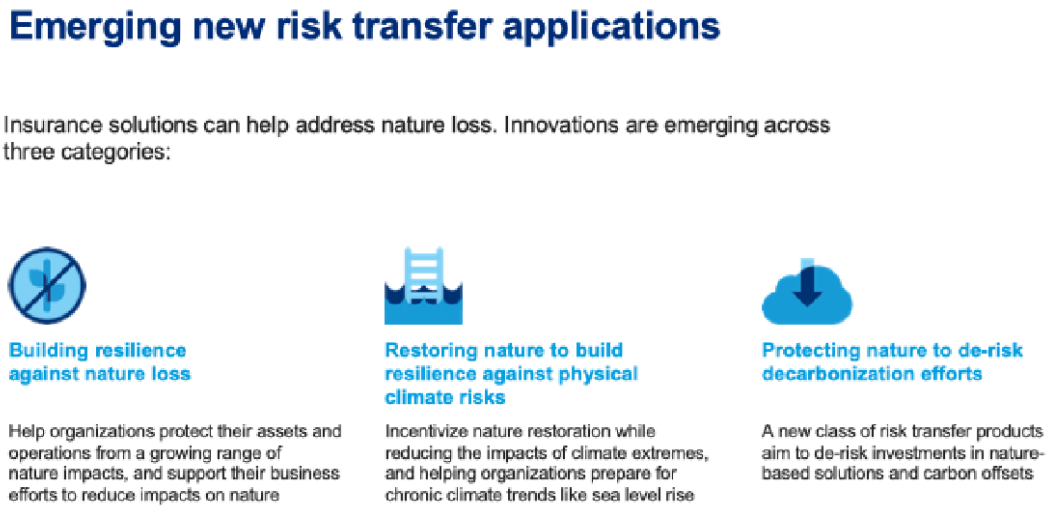

Figure 6 Emerging New Risk Transfer Applications (Source: Marsh 2024)

Equity and Social Considerations

Discussions on equity emphasized that BNG projects should be designed and implemented in a way that ensures benefits are distributed fairly across different urban areas, including underprivileged neighbourhoods (whilst recognising that the definition of ‘fair’ will vary from stakeholder to stakeholder, depending on their respective perspectives). Concerns were raised about BNG potentially leading to 'green gentrification,' where enhancements in green infrastructure might increase property values and displace lower-income residents.

The importance of involving local communities in the planning and execution of BNG projects was stressed. Engaging communities can help ensure that the projects meet the diverse needs of urban populations and do not inadvertently marginalize or exclude certain groups. This approach also helps in building support and ownership among residents, leading to more sustainable and accepted outcomes.

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Conclusion and Future Direction

There was consensus on the need for ongoing research into best practices for the integration of BNG with flood risk management. Participants advocated for interdisciplinary collaboration among urban planners, ecologists, engineers, and policymakers to develop comprehensive strategies that address multiple urban challenges simultaneously. Research and development into sustainable materials and construction practices that enhance biodiversity while reducing flood risks should be encouraged. For instance, permeable pavements and green roofs can contribute to stormwater management and habitat creation simultaneously.

Developing supportive and flexible policies that facilitate the integration of BNG into broader urban development and flood risk management strategies was seen as crucial. Such policies should be designed to adapt to evolving environmental, social, and economic contexts, ensuring they remain effective over time. Tools such as zoning laws, building codes, and environmental impact assessments could be modified to include criteria that promote BNG and flood risk mitigation.

Recent Reports and Guidance on Biodiversity Net Gain (BNG)

Environmental Policy Innovation Center Report (2023): This report explores the ambitious Biodiversity Net Gain policy in the UK, established under the 2021 Environmental Act. It aims for developments to result in a 10% net gain in biodiversity, making it one of the boldest policies globally. The report delves into the implementation strategies, key risks, and lessons from environmental markets in the US to guide UK policy evolution (Patel 2023).

Biodiversity Net Gain Guidance (2024): New guidance released in January 2024 ahead of the official implementation date on February 12, 2024, details the application of BNG for major and small developments. It includes updates on legislative requirements and practical steps for developers to achieve the required 10% net gain in biodiversity. This guidance emphasizes the benefits of BNG for local environments and outlines specific exemptions and the biodiversity gain hierarchy (Department for Levelling Up, Housing & Communities 2024).

CIEEM Biodiversity Net Gain Report and Audit Templates (2024): This document by the Chartered Institute of Ecology and Environmental Management (CIEEM) provides structured templates for creating BNG reports and audits. The templates help ensure that projects aiming for BNG follow the 10 Principles of BNG. They are designed for development projects but can be adapted for other land use change projects and appraisals. These resources facilitate the demonstration of measurable benefits to biodiversity compared to baseline conditions (CIEEM 2021).

Welwyn Hatfield Borough Council Biodiversity Net Gain Assessment (2024): This assessment by Welwyn Hatfield Borough Council outlines the strategies and methodologies for achieving BNG in local development projects. The document provides a detailed

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framework for evaluating biodiversity impacts, setting baseline conditions, and planning for a minimum of 10% net gain. It includes metrics, case studies, and guidelines for both on-site and off-site biodiversity enhancements.

3.4 Reflection and conclusion

The IL provided a valuable platform for multidisciplinary dialogue on the integration of BNG with flood risk management in urban planning. It highlighted the complexities and potential of using BNG not only as a regulatory requirement but as a transformative tool for enhancing urban ecosystems and resilience against flooding. While the challenges of implementing BNG in densely populated areas are significant, the discussions underscored the opportunities that innovative NbS offer for creating more sustainable and liveable urban environments. The IL identified the following priority areas which are now being explored further:

- Research and Collaboration:
  How to foster interdisciplinary collaboration among urban planners, ecologists, engineers, insurers, financiers, property developers, those who offer biodiversity credits and policymakers without wasting time and efforts?
  How to develop comprehensive strategies that address multiple urban challenges simultaneously?
- Policy Development:
  How to raise awareness about the options of integrating BNG into broader urban development and flood risk management strategies is crucial (?)
  How to navigate barriers - tools such as zoning laws, building codes, and environmental impact assessments could be modified to include criteria that promote BNG and flood risk mitigation?
- BNG underwriting solutions: Can BNG be a catalyst for new solutions?

International Collaboration

As part of the ongoing next phase of Part II mentioned above, the IL is planning knowledge exchange activities beyond the UK. Notably, IL experts are connected with ongoing work in this space in the US, most notably University of California Santa Cruz Center for Coastal Climate Resilience (CCCR) / Guy Carpenter / Army Corps of Engineers on the NbS for coastal risk management.

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4 Innovation Lab 2 - Methods to quantify flood risk reduction and co-benefits of NbS in the Netherlands Ethical concerns related to nature-based solutions

4.1 Overview

	Session 1: 16 November 2023	Session 2: 9 February 2024	Session 3: 4 April 2024
Organisations involved	Dutch Association of Insurers, Achmea, Rabobank, Ministry of Finance, VU-IVM	ASR, Dutch Association of Insurers, Achmea, Rabobank, VU-IVM	Municipality of Valkenburg aan de Geul, Dutch Association of Insurers, Ministry of Infrastructure and Water Management, VU-IVM
Experts participating (#)	40	14	10
Main topic of discussion	Defining the challenge; Introduction to the Innovation Lab objectives to a broad group of stakeholders.	In depth discussion with a specialized group of catastrophe modelling experts on new flood-risk models developed at VU-IVM and how they can be used by insurers.	In depth discussion with a specialized group of public sector experts on co-benefits valuation of NbS. Focused on the choice experiment that will be deployed in September, particularly on measures designed for Limburg and what attributes (characteristics) are relevant for stakeholders.

4.2 Introduction and purpose of the lab

Flood risk in the Netherlands has been a growing concern, exacerbated by climate change and the resulting extreme weather events. By connecting the academic research community with insurance industry representatives, policymakers, and local government officials, this Innovation Lab aimed to align theoretical knowledge with practical applications, addressing societal demands for NbS for flood risk reduction. This Innovation Lab facilitated a multidisciplinary dialogue aimed at enhancing methods for assessing the flood risk-reduction potential and co-benefits of NbS in the Netherlands. The first session served as an introduction to the Lab, the second focused on catastrophe modelling and risk reduction, and the third session served as a focus group on what NbS were planned by stakeholders and how to assess their co-benefits. Across the three sessions, the Lab brought together

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experts from the Institute for Environmental Studies (VU-IVM), Rijkswaterstaat, the Municipality of Valkenburg aan de Geul, the Dutch Association of Insurers, and other key organizations to exchange knowledge and collaboratively improvements to current methods to assess NbS.

The Innovation Labs explore the potential for new nature- based insurance, investment instruments and revenue models through a set of business case assessments. We aim to discuss with all relevant stakeholders the new methods to assess the effectiveness of NbS for climate risk. Providing a comprehensive assessment that identifies who benefits from NbS is the first step to understanding how we should finance them. Hence, we discuss with insurers what information they would need to foster investment in NbS through, for example, premium reductions. On the other hand, we discuss with local stakeholders on the benefits for wider society. This could be the basis for a public-private partnership due to the wide array of beneficiaries.

This innovation lab is linked with the objectives of Work Package 4, specifically with the second task and deliverable, which aims to "improve selected methods for assessing risk reduction and co-benefits of NbS in the case studies based on stakeholder needs (input from Work Package 2)". This includes integration of NbS in disaster risk assessment models, as we discussed in Session 2 with the stakeholders from the insurance sector, to improve damage estimates of natural hazards under climate change and how much of this damage can be avoided by NbS. Moreover, this task will produce additional evidence of ecosystem services by NbS in the Netherlands and how individuals value these using stated preference surveys (choice experiments). The set of attributes (characteristics) will be derived both from the literature review (D4.1) and Session 3 of this Innovation Lab.

The next section will briefly introduce the case study that will serve to illustrate the improvements in methods derived both from our discussion with stakeholders in the Innovation Labs and the systematic review conducted in Deliverable 4.1.

The European Floods

In the summer of 2021, an episode of extreme precipitation caused devastating flash floods in several European countries, including the Netherlands, the United Kingdom, Germany, Belgium and Luxembourg. Several thousands of people had to be evacuated from their homes. The human losses were devastating: 243 died because of the floods (Deltares, 2021). In terms of assets, it is estimated that, only in the Netherlands, monetary losses amounted to 350 - 600 million euros (Kok et al 2023). This highlighted the need for improving the risk management system in place with new adaptation solutions.

In this context, several NbS have been planned (or already implemented) by local authorities. However, the full potential of NbS is unclear, which limits further investments. Hence, we choose the Limburg region, the main impacted area in the Netherlands, as the focus of our case study and Innovation Labs. We will show our new model, that accounts for NbS, to insurers and discuss how this could impact premiums. This could improve insurability and

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reduce the insurance protection gap. This could be seen as a redistributive policy, because an enhanced flood insurance coverage implies that less damage after a flood event is paid directly by flooded households. Additionally, we discuss with local stakeholders in Limburg which co-benefits they believe to be more important, based on the NbS already in place in the Limburg region.

4.3 Outcomes and results

Session 1: Introducing the Innovation Lab at the Dutch Association of Insurers

The first session of the innovation lab was organized under the umbrella of the Climate Finance Academy initiative, which aims to connect climate science and the financial sector through collaborations between the Institute for Environmental Studies (VU-IVM), the Royal Netherlands Meteorological Institute (KNMI) and several financial institutions such as Achmea (one of the largest financial service providers in the Netherlands) and the Dutch Association of Insurers. This IL aims to improve methods for assessing climate risk, and especially risk reduction from nature-based solutions for insurance, as well as the co-benefits of nature-based solutions. Both understanding the risk reduction and co-benefits are key for designing sustainable investment strategies in nature-based solutions. The IL was launched on November 16th in The Hague, at the headquarters of the Dutch Association of Insurers. It was part of the 10th climate change conference for the financial sector titled "Focus on the weather for the future: how do we insure this?". The conference was attended by about 150 employees working on climate change at Dutch financial sector organizations, including members of the Dutch Association for Insurers, the Dutch Banking Association and the Pension Federation.

The event overall was successful, and the attendees were engaged and interested in the different presentations. The contact details for the next session of the Innovation Lab have been provided to them in case they want to take part in the subsequent sessions. The discussion with the stakeholders focussed on the importance of improving climate risk assessments, which will be focussed upon in more depth in the second session of the IL. Another interesting discussion raised by one of the attendees was about the opportunities available for the insurers facing increasing climate risk. Nature-based Solutions were mentioned to use the potential of nature to reduce climate risk and provide several co-benefits that will also improve the quality of life of the community, besides reducing the number of claims and improving insurability. A third innovation lab session will be organized to focus in more depth on the methods for assessing these co-benefits and how the assessment of these benefits can be improved to make them relevant for practice.

To wrap up, the IL launching event was a key milestone in the cooperation between the VU-IVM NATURANCE researchers and financial institutions. We expect that our following Lab sessions will be greatly benefited by this network of experts from the financial sector. If we combine their expertise with the current academic knowledge from the NATURANCE partners and public sector representatives, we can have a very wide range of stakeholders

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for our lab discussions, which would positively impact the outcome of the lab. Moreover, the first IL session helped to prioritize the topics for the subsequent IL sessions. These will focus on the improvement of methods for assessing climate risk for insurance using catastrophe models, including risk reduction from NbS, and the methods for assessing co-benefits of NbS.

Session 2: Improved methods to assess flood risk reduction potential of NbS in the Netherlands

The second session of the VU-IVM Innovation Lab focused on improving methods to assess the risk-reduction potential of NbS. It aimed to combine the academic in-house expertise of flood-risk modelling at VU-IVM with insights from stakeholders in the insurance sector. The main goal was to better understand the views of insurers regarding NbS risk assessment and financing. A new hydrological model was introduced to stakeholders, which will be used in conjunction with flood damage and an insurance model to estimate the impact of NbS for insurers. The session also provided a platform for discussion about how insurance can utilize these outputs and what additional information would be relevant to mainstream NbS financing.

At the beginning of the session, the first two experts presented the latest advancements in in-house flood-risk modelling and its application to insurance modeling to estimate the effects of NbS on insurance affordability and premiums. This session of the lab, as well as the following one on co-benefits, focused on the 2021 Limburg flooding case study. In the summer of 2021, extreme precipitation led to devastating floods across several European countries. In the Netherlands, it mainly impacted the region of Limburg, and the total damage was estimated around €350 – €600 million, of which insured losses accounted for €224 million (Kok et al., 2023). This event highlighted the necessity of an improved flood defence strategy and improved insurance coverage of flood risk in the Netherlands.

The next presenter, an VU-IVM PhD candidate, proposed an updated hydrological model that utilizes an object-based map instead of a traditional land cover map, enhancing the level of detail in exposure data. This will provide a more detailed inundation map and a higher degree of detail in exposure data, based on different types of buildings affected. To reach the proposed goal, first there is a need to build an object-based dataset and to collect object-based damage curves, which assess the vulnerability to flood events. Object-based implies conducting the flood risk on a building scale level, for which building scale exposure and vulnerability information is required. Significantly, the updated models will incorporate NbS, allowing for the estimation of their physical impact and annual avoided losses.

The presenter introduced the Dynamic Integrated Flood Insurance (DIFI) model. The DIFI model is used to assess the societal consequences of natural catastrophe insurance policy trade-offs. The model can estimate the level of insurance demand of a particular region, given the risk of flooding, the perceived risk and the cost of insurance. The model uses current and future flood risk projections to estimate insurance premiums, under varying

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premium-setting rules applied in insurance market structures found in Europe. Flood risk, distorted by a parameter that introduces the way this is subjectively perceived by individuals, together with premiums, potential coverage requirements, and potential premium discounts after applying DRR measures, feed into a simulation of consumer choice regarding insurance uptake. The model applies Expected Utility Theory to assess which choice most improves the household's welfare, given their perceived probability of impact of floods. Implementing the new hydrological model would allow us to estimate the impact on premiums, insurability and insurance demand for different types of NbS.

All the participants were very participative, which led to an insightful and engaging discussion. We have grouped the topics of discussion in three main categories: "how can the models improve to be useful for the insurance companies", "investing in NbS" and "potential stakeholders to include in future discussions".

How can the flood-risk models be improved to be relevant for insurance?

Our private sector stakeholders (ASR, Dutch Association of Insurers (VVZ) and Achmea) highlighted that all proposed innovations by VU-IVM modellers are new for insurers. Modelling is usually purchased from a third party, and it is considered to be a "black box" at times. VU-IVM and ASR experts discussed the possibility of creating open in-house models for insurers to use in the future. This would also help the case for NbS, since a better understanding of their benefits could also impact premiums and affordability in areas where they are implemented as long as they prove to be effective.

Another suggestion to improve modelling from the insurers (ASR) was to include household adaptation measures in flood risk assessments. This could also motivate insurers to offer discounts to those households that lower their risk by taking adaptive measures. The object-based approach was also interesting for the insurers. The insurers were asked whether we could expect a change in premiums reflecting the lower risk due to NbS. The response was that property markets are sufficiently competitive so risk-reduction should in principle be reflected by a lower premium. However, ASR representatives highlighted that some insurers estimate premiums using an average of a larger area. This also helps to improve insurability of high-risk areas, where it would be uninsurable otherwise. Insurability issues, mainly in outer dykes' areas and certain very low-lying regions, were highlighted by VVZ and ASR, who expressed interest in understanding how NbS could enhance insurability in these areas. Using our new object-based model could help to differentiate premiums to account for the impact of NbS but also offer discounts for adaptive measures. Moreover, this provides an incentive to examine both types of premium calculations (case-specific vs average risk) in our modelling outputs. Additionally, the insurers suggested that including a differentiation between flood risk from failure of primary and secondary flood defences in the Netherlands in assessing the impact on premiums in models.

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Investing in NbS for flood-risk reduction

Our stakeholder from VVZ explained that insurers currently invest in green bonds, which could include NbS (e.g. room for the river program), rather than investing in NbS directly. These are believed to be stable and provide diversification on the portfolios, as well as contributing to building a net-zero investment portfolio. Nevertheless, the consensus by insurers was that the government should be taking the lead for investing in risk-reduction measures. Insurers typically specify insurance coverage contracts for one year, which can create a free-rider problem in the competitive insurance market: one insurer can pay for a NbS, but if the household changes insurers in the following year, they will not enjoy the benefits. This same issue can arise with multi-year contracts if the NbS only reduces risk in the longer term.

The example of the weatherproof program in Amsterdam was discussed. The government is pushing this program since it has more beneficiaries aside from insurers such as local businesses, real estate and the local community. We highlighted that, as part of the NATURANCE project, we will be performing a comprehensive cost-benefit analysis that not only combines risk-reduction and co-benefits, but also identifies the different beneficiaries to design fair financing strategies. It was generally expected by the lab participants that the WP4 insights into how NbS can improve insurability of flood risk and lower premiums can act as a reason for enhanced government investments in NbS.

Other potential stakeholders

In the last section of the meeting, we discussed which other stakeholders could be interested in the modeling outputs. We will already meet with local representatives of Limburg for the third session of our lab, which focuses on the co-benefits of NbS. The ASR expert suggested that we should get real estate stakeholders involved. Risk-reduction is also important for real estate investments. Moreover, farmers that are clients of such investors as well as of insurers and banks who invest in land to lease it get a discount on rent lease if they implement NbS.

The VVZ stakeholder noted that the analysis could also be relevant for businesses where adaptation measures could be better stimulated by insurers, and that NbS might influence the climate risk label of a building that are currently being planned, which banks and real estate investors might respond to, affecting the real estate investment side of the insurance industry.

Other stakeholders that could be involved at later stages include the Dutch Association of Banks, the pension sector, local businesses, the tourism sector, NGOs like Greenpeace, and the Delta Program in the Netherlands.

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Session 3: Improving choice modelling design and co-benefits assessment with local stakeholders

The third session focused on improving methods to assess the co-benefits (and disbenefits of NbS). This is extremely important in order to conduct a comprehensive assessment of NbS, which can then inform investment decisions. At the beginning of the session, the choice experiment that is planned for Limburg was introduced so all participants were aware of how the input they provided would feed into research for NATURANCE.

The stakeholders highlighted that, even if there are already discussions in place to implement NbS in Limburg, they are still considering what could be the optimal solution. They were convinced that a mixture of measures (green and grey) would be needed. Hence, we will adapt our choice model choice sets accordingly, using grey solutions as the baseline and giving two nature-based options that will be implemented on top of the traditional solution, at an extra cost. Insurers also showed interest in assessing property-level measures in the broader context of NbS and hybrid measures. Some stakeholders also highlighted the importance of understanding and communicating the various benefits and potential unintended effects of NbS to different stakeholder groups, including local communities, insurers, and property owners.

Another challenge identified by stakeholders was the concern regarding land use changes (spatial constraints) and the role of private/public land ownership in the decision-making process. This is one of the potential unintended consequences of NbS. As it was also highlighted in our systematic literature review (D4.1), there is a lack of disbenefits analysis. In this case, since the stakeholders considered the main concern in a country such as the Netherlands, we will include loss of agricultural land as part of the trade-off in the choice cards that will be shown to respondents.

4.4 Reflection and conclusion

Due to climate change, flood risk will increase both in frequency and intensity in the next decades. Events like the 2021 European floods highlight the deficiencies of current risk-management strategies. NbS and hybrid solutions appear as promising options to reduce flood-risk and provide simultaneous co-benefits for the wider society.

This lab serves as a collaborative platform, integrating insights from the academic, insurance, and governmental sectors to improve flood-risk assessment models and non-market valuation methods in order to explore NbS's financial viability. The objective is to improve methods to assess the benefits of NbS applying the feedback received from our stakeholders. On the one hand, insurers highlighted that the current models developed at VU-IVM, which include the impact of NbS, are new for them and could potentially impact premiums or insurability, if there is empirical evidence that NbS reduces flood risk. On the other hand, local governments are concerned about land use changes and believe that the disbenefits of land use change should be taken into account when considering investment in NbS.

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The improved methods will improve the current understanding of the benefits of NbS. This can allow for better investment decisions, both for private and public sectors. Traditional assessments usually neglect co-benefits, which can lead to underinvestment in NbS. We will apply the new improved methods to the case study of Limburg in order to produce a social cost-benefit analysis that shows the total societal benefits, and identifies the beneficiaries. In this way, public-private partnerships can be an optimal solution to mainstream NbS investment since insurance companies are interested in the flood-risk reduction aspect, but the government is also interested in the other co-benefits that NbS provide. As it was mentioned during the session, institutional investors can also be interested in the co-benefits since they can increase the value of their assets (mainly real estate).

There are still several challenges that were identified in the sessions that should be addressed in the future. The spatial constraints are still likely to be a challenge for NbS development in certain places like the Netherlands since the land can be privately owned. Moreover, current insurance models do not always consider NbS or climate change trends when estimating insurability or premiums. Despite the potential methodological improvements in science to include NbS and climate change in risk assessment models, these improvements should still be adopted by the industry which can develop similar models as the state-of-the-art models applied in science. Our stakeholders mentioned that they would be very interested in a collaboration with academia for this purpose. Regarding the co-benefits, some public sector representatives highlighted the challenges of communicating co-benefits to the citizens since this is likely to have a big impact in acceptability/support for NbS policies.

NbS investment has the potential to be a shared interest between public and private sectors, which means that a public-private partnership could be an effective strategy. This partnership could benefit from both public funding and private investment to scale NbS implementation, addressing the challenge of short-term insurance contracts and the benefits these solutions provide over longer periods. For this to be realistic, an accurate mapping of beneficiaries is crucial, but this could pave the way for tailored investment strategies for NbS in the future.

4.5 Scorecard

	Summary	Scale (1 to 5, 0 in case question cannot be assessed)	Score
Problem statement, Current baseline & Innovation	How well does the developed business case: -Identify the challenge/need for innovation regarding the link between nature and insurance?	1 (Significantly below current standard/ baseline)	14/15

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	-Provide a solution to the identified challenge? -How new and innovative is the developed business case solution?	5 (Significant improvement to current standard baseline)	
Implementation & Execution	How well does the developed business case (max. 5 points per question): -Identify the key groups and stakeholder that are needed for implementation? -Outlines the implementation strategy? -Outlines and addresses risks surrounding the implementation?	1: Makes implementation very unlikely 5: Makes implementation very likely	13/15
Finance	How well does the developed business case (max. 5 points per question): -Demonstrate the ability to get financed? -Describes the need, use and source of funding? -Outlines sustainable financial expectations?	1: (Does not at all contribute to getting financed) 5: (Does significantly contribute to getting financed)	10/15
Impact	How well does the developed business case (max. 5 points per question): -Show how the innovation can lead to a positive impact for nature? -Show how the innovation can have a positive impact for the insurance sector? -Show that the innovation can lead to a positive impact for society and communities including climate resilience, equity and participation?	1 (No or negative impact) 5 (Highly significant impact)	15/15
Total			**52/60**

Identify the challenge/need for innovation regarding the link between nature and insurance?

The innovation lab highlights the main challenges that may limit investment on NbS: the lack of a comprehensive assessment of all benefits and beneficiaries. There is a need to improve modelling in order to inform insurers about the risk-reduction potential. (4/5)

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Provide a solution to the identified challenge?
The innovation lab proposes new methodological improvements, both for risk-reduction and co-benefit assessments, that were supported by stakeholders' concerns about investments in NbS (5/5)

How new and innovative is the developed business case solution?
According to our stakeholders from the insurance sector, they do not have an in-house model that can capture small-scale NbS as we are developing. This is also supported by our systematic literature review (D4.1). Similarly, both the literature review and our public sector stakeholders support including disbenefits as part of the choice for respondents in co-benefit valuation studies. (5/5)

Identify the key groups and stakeholders that are needed for implementation?
Insurers, banks and insurance associations were invited to the risk-reduction modelling event since they are the main actor that can benefit from improved models. Regarding co-benefits, local government representatives were the main target. The identification of stakeholders was optimal but it would have been better to have more stakeholders in the workshops. However, the business case / financing strategy does consider all relevant actors and their incentives to invest in NbS. (4/5)

Outlines the implementation strategy?
The implementation of the new methods is clearly defined in the IL. The results of the case study analysis with the improved methods will be available at a later stage of the project. Nevertheless, regarding the business case or investment strategies, there is still a lot of work until our proposed public/private partnerships help to mainstream investment in NbS (4/5)

Outlines and addresses risks surrounding the implementation?
The risks and challenges are clearly defined in the last section of the report. Our stakeholders were very insightful in expressing their concerns about NbS investment and what data they need from our improved models to guide their decisions (5/5)

Demonstrate the ability to get financed?
Since our IL focuses on methods, the ability of NbS to be financed lies outside the scope. First we need to implement our improved methods to guide decision making for both insurers and the public sector. However, this is the first step to better understanding of their total benefits. (4/5).

Describes the need, use and source of funding?
The source of funding is currently mainly public, but we argue that public/private partnerships may help to increase investment, if NbS proves to be reliable in reducing flood-risk. (3/5)

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Outlines sustainable financial expectations?
So far, government funding is the main source for NbS worldwide. Insurers seem interested in NbS but it's hard to guarantee that they will be willing to invest in the short term. (3/5)

Show how the innovation can lead to a positive impact for nature?
The business case shows that this methodological innovation can have a great impact on NbS investments. Not only by showing insurers the real impact of NbS on flood-risk reduction, but also by also considering the land-use constraints. (5/5).

Show how the innovation can have a positive impact for the insurance sector?
Insurers may be interested in investment in NbS if our models prove they can improve insurability and reduce claims. This modelling approach seems to be new for them too and it could improve their accounting for NbS in their current models. (5/5)

Show that the innovation can lead to a positive impact for society and communities including climate resilience, equity and participation?
The combination of risk-reduction and co-benefits can make a strong case for investing in NbS in the future. This can have a positive impact in, not only resilience, but also provide several other benefits for the local community: air quality regulation, recreation, water quality, etc. All local residents will be able to enjoy these benefits. (5/5)

5 Innovation Lab 3 - Harnessing insurance to promote nature-based solutions for wildfire risk management

5.1 Overview

Solsona, Spain Session. After its launch at the Naturance webstival, the first in-person meeting of the Wildfire Insurance Innovation Lab (WIIL) was held as part of the Firelogue project Cross-sector dialogue for Wildfire Risk Management in Solsona, Spain, July 4-6, 2023. At this meeting FireLogue's five different working groups, including the Insurance Working Group of which the WIIL was part, met in parallel to discuss wildfire risk management (WFRM) innovations from their respective topical perspective. This was the third IWG meeting overall, following a pre-launch with a roundtable on equitable wildfire risk-sharing at the "Fire Ecology across Boundaries: Connecting Science and Management" Conference in Florence, October 4-7, 2022, and an official launch at the Understanding Risk Global Forum (UR22) focus days, December 1, 2023, in collaboration with NATURANCE (Nature for insurance, and insurance).

Nea Makri, Greece Session

The second meeting took place in Nea Makri on April 10, 2023. Building on the background and ideas emerging from the Solsona meeting, this meeting of the WIIL represented a pivotal opportunity to collaboratively craft recommendations for national regulators, policy makers and the European Commission. Discussions centred on enhancing insurance coverage for WFRM, particularly through innovative solutions such as community-based

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and parametric insurance, as well as the potential of leveraging insurance to promote the adoption of NbS for WFRM.

Vienna, Austria Session

The final session of the Innovation Lab took place in Vienna on May 22, 2024, in conjunction with the Naturance Festival. It was attended by 12 participants, all in person. The purpose of the meeting was to delve into technical and strategy issues that had arisen in the prior two WIIL meetings. The discussion focused on the use of wildfire models for incorporating nature-based solutions into wildfire insurance schemes, the pricing and regulation of parametric wildfire insurance products and the potential of community-based insurance systems for incentivizing community-based NBS.

5.2 Introduction and purpose of the lab

Wildfires are posing increasing threats as climate change and land use choices interact, creating challenges for public authorities, communities and insurers as they struggle to cope with increasing risks. The Wildfire Insurance Innovation Lab (WIIL) assembled a group of insurance, wildfire and ecology experts to discuss how insurance can help to mitigate and adapt to these risks, especially with nature-based solutions (NbS). The aim was to find innovative ways to close the wildfire insurance gap, particularly in Mediterranean countries, and at the same time promote the inclusion of NbS for mitigating wildfire risks. The WIIL was carried out in close collaboration with the Insurance Working Group of the EU Horizon Firelogue project.

Solsona, Spain Session

The inaugural in-person meeting of the WIIL centered on discussions related to insurance for WFRM and, in particular, the potential for leveraging insurance to promote the adoption of nature-based solutions (NbS) for WFRM. With a focus on Mediterranean EU countries, the ultimate aim of the workshop was to address the question: What innovative insurance products/systems can support NbS for wildfire risk management? To address this question, three additional questions were on the agenda:

What is the current landscape of wildfire insurance across the Mediterranean and more broadly the European Union, and what are the gaps in coverage?

The WIIL reported a wide variation in levels of coverage with some countries (e.g., Italy) relying heavily on post-disaster government relief. Insurance provision ranges from primarily public (e.g., Spain and Norway) to wholly private provision (e.g., Germany) with some countries supporting hybrid public-private systems (e.g., France). It appears that no insurance system has built in strong incentives for wildfire risk mitigation.

What are nature-based solutions for wildfire mitigation in different landscapes?

The WIIL discussions proved this question to be controversial. Competing perspectives on wildfire NbS show a tradeoff between reducing wildfire risk, e.g., with forest thinning,

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prescribed burns and/or animal grazing to reduce fuel load, and promoting biodiversity, e.g., by rewilding, re-wetting and allowing deadwood to accumulate on the forest floor. The consensus was 'no one NbS fits all' and it will depend on the landscape, e.g., wilderness, abandoned farmland or urban-wildland interface, as well as on the context, e.g., shrub, grasslands, boreal forests, etc.

How can insurance support NbS?

Discussions in the WIIL led to the development of a taxonomy of insurer activities that can enable NbS, including the underwriting and investment sides of the business. Underwriting activities include offering cover for NbS loss and damage (e.g., coral reefs), de-risking NbS operations (e.g., prescribed burns), incentivizing NbS with insurance pricing (e.g., buffer strips), enabling NbS financing (e.g., debt for nature swaps), and declining cover for nature-negative projects (e.g., the African crude oil pipeline). In addition, insurers have large investment portfolios that they can make more transparent and directly support NbS with nature-negative divestment, nature-positive investment, and philanthropic NbS investment.

The WIIL was attended by 13 in-person and 14 virtual attendees representing six major insurance companies (Willis Towers Watson, Marsh McLennan, Forest Re, Swiss Re, AXA, Prudential Financial) and one supporting consulting firm (MITIGA Solutions) as well as Spain's public Insurance Compensation Consortium (Consorcio de Compensación de Seguros). In addition, forest ecologists and biodiversity experts from the Forest Science and Technology Centre of Catalonia (CTFC), International Institute for Applied Systems Analysis (IIASA) and Princeton University, and insurance experts from the World Bank, OECD, IIASA, Technical University of Denmark (TUD) and LSE, were present at the workshop.

Nea Makri, Greece Session

The Wildfire Insurance Innovation Lab proceeded in seven discussions:

- The imperative of closing the wildfire insurance protection gap in the EU
- Innovating smart solutions to close the wildfire insurance coverage gap: Community wildfire insurance?
- Innovating smart solutions to close the wildfire insurance coverage gap: parametric wildfire insurance?
- How can and do insurers invest (divest) in nature?
- Incentivize wildfire NbS with differentiated pricing, even refusing cover for nature-negative projects
- How underwriters support wildfire risk reduction via NbS
- What is the role of the EC and Member States?

The WIIL, which was part of the Firelogue Working Group meeting, was attended by 10 in-person and 16 virtual attendees representing three major insurance companies (WTW, Marsh McLennan, Carpenter Turner of Guy Carpenter) and one supporting consulting firm (MITIGA Solutions). In addition, forest ecologists and biodiversity experts from CTFC and

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IIASA, and insurance experts from the World Bank, OECD, IIASA and LSE, were present at the workshop. As an important addition from the Solsona meeting, there was attendance from the European Insurance and Occupational Pensions Authority (EIOPA) and the Greek Insurance Association.

In-person participants had the opportunity to join a voluntary field trip of wildfire sites in the Attica region on April 9th and to attend a crosscutting working group meeting on April 11th. The field trip traced the 2018 wildfires and demonstrated innovative approaches for preparing for wildfires. As NbS were not yet included in the approach, discussions around their applicability and the options for insurance to support their use emerged.

Vienna, Austria Session

The issues discussed were focused at the intersection of insurance, wildfire, and nature-based solutions. This was followed by a round of introductions where each participant was asked about their view on the most pressing issue for insurers to support NbS. In this round, a few themes became apparent, including the need for robust evidence of the effectiveness of NbS, as well as the need for policy to set up structures that support the adoption of NbS, whether through incentive schemes or direct regulations. The core discussion focused around three main themes:

- The landscape of wildlife insurance across the Mediterranean and EU and the gaps in coverage
- The NbS for wildfire mitigation in different landscapes
- How insurance can support NbS

5.3 Outcomes and results

Solsona, Spain Session

The core session of the Solsona workshop, specifically dedicated to the WIIL, turned to identifying innovative products and approaches that insurers could develop to help reduce the risk of wildfire damage, biodiversity loss and climate change, notably with NbS. By building on the three earlier sessions, this final session followed the IL methodology of the NATURANCE project.

The first presentation started the discussion by sharing insights around adapting community-based risk reduction strategies from the US National Flood Insurance Program (NFIP) to address wildfires. The NFIP, as the public underwriter for flood insurance in the United States, emphasizes affordability and access to flood insurance for participating communities. One notable aspect is the Community Rating System (CRS), which provides premium discounts to households based on the implementation of risk reduction measures by the community. While the CRS primarily focuses on flood-related measures, there is interest in exploring its applicability to wildfire risk reduction. The integration of NbS within the CRS, such as open space preservation and natural stormwater management, highlights their potential for community-based wildfire insurance programs. The question of

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transferring the NFIP approach to the European Union context was also raised, emphasizing the need for tailored strategies that address the unique characteristics of wildfire risk in different regions and flagging that including wildfire perils in national CAT insurance schemes as one possible low-hanging fruit option, e.g. in France, Romania, Spain and the Netherlands.

The next presentation continued the WIIL with insights from the French Meadows study in California. This study, conducted in Placer County, CA, examined the landscape-scale effect of NbS on reducing wildfire risk across 28,000 hectares. One key challenge was the translation of NbS actions into actual premium reductions, which varied between indemnity and parametric insurance approaches. For indemnity insurance, factors such as expected loss from risk models, FSIM fire models, Willis Watson Wildfire score, and considerations of uncertainty, expenses, and profit were considered. Simplified models of burned areas based on academic research played a role in assessing burn area reduction. In the case of parametric insurance, historical burn areas and severity were utilized to develop an index for the parametric product, with amended burn areas capturing the effects of risk reductions. However, it was noted that the implementation of the model may differ in practice, as there are multiple levels of novelty and complexity involved. The example of the Tahoe Donner region, where forest management has been carried out for 15 years, demonstrated the potential to present proven results to the insurance market. Nevertheless, underwriters appeared hesitant to take on the risk associated with NbS, potentially due to a lack of understanding. To translate the model for the European Union context, a suggested approach involved progressing from academic research to community uptake, product development, NbS education, and ultimately insurance market adoption.

In the following session, the presenter picked up on the point of EU financing for wildfire response measures and considerations for the future. Historically, the EU has focused on preparedness measures such as purchasing equipment and vehicles, while neglecting the mobilization of human resources and probabilistic analysis. The creation of a probabilistic model, acknowledging the challenges compared to risks like hurricanes with view to gaining insights into future losses and determining the appropriate insurance coverage, was flagged as a way forward. The EU fire peer review assessment emphasized the need for financing, including estimating, accounting, and disclosing contingent liabilities to the public sector and critical sectors such as electricity and roads. Proactive investments in wildfire mitigation were also highlighted. However, there is a lack of quantification of avoided losses, similar to what has been done for mangroves in managing flood risks. This gap needs to be addressed to better understand the impact of wildfire management strategies. The discussion also raised the question of valuing public forests in addition to commercial forests. The UN Capital Development Fund (UNCDF) provides cities with affordable climate insurance with pre-arranged premiums, prompting the consideration of reducing premiums while risk-reduction measures are underway, even if they are not yet completed. The role of

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insurers as investors was mentioned, noting that they can promote nature-positive solutions but have historically discouraged investment in activities harmful to nature.

Main insights derived

Many innovative ideas emerged from the discussions for products or activities that can support NbS for WFRM, including:

- Innovation: Develop community-based insurance products modeled after the US National Flood Insurance Program's Community Rating System, which awards households and businesses with premium reductions if their community takes DRR measures, including NbS
- Innovation: Reduce premiums on parametric wildfire insurance products based on NbS measures in place (the Willis Towers Watson model of the French Meadows national park showed premiums could be reduced by up to 43% with forest management NbS). Note, unique to wildfire, the hazard (as separate from exposure and vulnerability) can be reduced with NbS, meaning that parametric products, where the trigger is based only on the hazard, can offer incentives for risk reduction.
- Innovation: Based on the UNCDF, which provides cities and other sovereigns in the developing world with affordable climate insurance with pre-arranged premiums and premium discounts for DRR, reform the mandate of the EU Solidarity Fund (that provides ex post relief to MS governments after major disasters). Indeed, given the relatively limited correlation between wildfire occurrences across different countries, there is potential for leveraging diversification and risk pooling advantages on a European Union (EU) scale. Some additional ideas for the EU Solidarity Fund.
    - Change from a compensation fund (European Union Solidarity Fund, EUSF) to an EU-backed re-insurance mechanism.
    - If compensation fund, require DRR and specified investments in NbS to remain a participant.
    - If re-insurance system, incentivize premium reductions based on investments in DRR/NbS.
- Innovation: Assure that offsets and carbon credits from investing in forests support NbS for wildfire risk management, e.g., by requiring planting of mixed forests, fire-resistant vegetation, fire breaks, and long-term maintenance measures.

Policy recommendations can address different scales (EU, national, regional, local) and target different actors (e.g., public policy makers, enterprises, insurers, NGOs and other civil society organizations). The focus of the WIIL was primarily on public policy makers and regulators at the EU and Member State scales. Before policy recommendations can be placed on policy agendas, it is essential that current policy is well understood. In our case, this includes, among many other policy documents, the EU Financial Directive, the EU taxonomy, insurance regulation, EU Biodiversity Strategy, Forest Strategy, the EU Nature Restoration Law, and many national strategies for wildfire.

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Building on the insights from the Solsona discussions, the WIIL tentatively tabled some topics for policy briefs (targeting EU and national policy makers) within the bounds of our nexus topic (insurance, NbS, wildfire), namely:

- Closing the wildfire insurance protection gap: Policy Brief with recommendations from the WIIL on an EU-national 'smart' insurance system that combines both incentives for DRR/NbS and equity (solidarity). An innovative idea is to use a risk-layer approach with the EU Solidarity Fund (reformed) absorbing extreme losses (pooling risks across MSs) and public-private insurance systems absorbing middle-layer losses – both with strong incentives for NbS.
- Insurance to support NbS: Policy Brief laying out the different concepts of NbS and how insurers can provide support. This support, especially for the conservationist perspective, will require policy reform at all scales – we need additional work in this area. How can insurers support implementation of the Nature Restoration Law?
- Parametric wildfire insurance: Policy brief on its unique potential to link with DRR/NbS, including the regulatory issues of such products.
- Supporting Nbs with biodiversity offsets and carbon credits: Policy Brief to suggest reforms to the systems in place to assure support for NbS.
- Community-based insurance: Policy Brief reporting on the Sardinia pilot and needed reforms at relevant scales for its implementation.
- Public/private catastrophe insurance: Pros and cons of different insurance models as applied to wildfire risk management.

Nea Makri, Greece Session

The imperative of closing the wildfire insurance protection gap in the EU

The first session provided a comprehensive overview of wildfire risk financing in Europe and highlighted the pressing need to bridge the resilience gap through a layered risk management approach encompassing both wildfire risk reduction and risk transfer strategies. Drawing from EIOPA statistics, the persistent underinsurance of climate-related losses across the European Union was underscored. The presenter emphasized the heterogeneous landscape of disaster-related liability management in Europe, particularly concerning wildfires. our distinct approaches were highlighted: i) public or public-private insurance systems, exemplified by Spain's CCS and France's CATNAT system; ii) systems featuring legally established ex ante government disaster relief funds, such as Austria's KatFonds, which may not be synchronized with market-based insurance; iii) predominantly market-based systems, with governments intervening on an ad hoc basis during extreme disasters, as observed in Germany and Sweden; and iv) predominantly ad hoc approaches to risk financing, wherein insurance markets for wildfires and other hazards are nascent, and governments act as quasi-insurers with limited legal frameworks for compensation, as seen in Italy, Greece, and Portugal (although the latter two have made important strides towards passing legislation that clarifies disaster-related contingent liabilities).

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Against this backdrop, the critical importance of closing the wildfire protection gap was stressed, with several reasons given for its need. Firstly, adequate insurance coverage is indispensable for safeguarding the financial stability of individuals, businesses, and communities affected by wildfires. Insufficient coverage could lead to prolonged financial hardship and economic instability for those impacted (Auer 2021). Secondly, closing the wildfire insurance gap is pivotal for enhancing resilience in the face of future disasters. As highlighted in the Sendai Framework for Disaster Risk Reduction 2015-2030, comprehensive insurance coverage enables better preparedness and response to wildfires, thereby mitigating their impact and facilitating quicker recovery. Furthermore, closing the gap is imperative for promoting equity and social justice. Vulnerable populations often bear the brunt of wildfire disasters but may lack the financial resources to protect themselves adequately (Osmont et al. 2020). Closing the gap can help level the playing field and ensure equitable access to funding for more resilient post-wildfire recovery. In conclusion, the presenter emphasized that addressing the wildfire insurance coverage gap is thus not merely a matter of financial prudence but a moral imperative that is about safeguarding lives, livelihoods, and the future of our communities.

Innovating smart solutions to close the wildfire insurance coverage gap: Community wildfire insurance?

During the session on Innovating 'smart solutions', the presenter highlighted the intricate issues surrounding wildfire insurance and the incorporation of NbS to mitigate risks. She emphasized that the protection gap in wildfire-prone areas extends beyond insurance to encompass a broader resilience gap, underscoring the importance of implementing risk reduction measures as a primary step. Various community-based insurance models were outlined, such as pooled solutions and aggregator models, aiming to cover entire communities rather than individual properties. However, significant challenges persist regarding premium payments and the long-term sustainability of these models, particularly in fostering effective collaboration between community institutions and insurers.

Insights provided during the session included the multifaceted nature of wildfire risk, encompassing both climatic factors and human activities such as arson and negligence. Additionally, perspectives from Spain and Greece highlighted the relevance of tailored approaches to each country's context and existing insurance infrastructure. The importance of capacity building in enhancing community resilience and understanding insurance mechanisms, advocating for cross-stakeholder collaboration, was emphasized.

Further discussion revolved around the potential of model systems like the US National Flood Insurance Program (NFIP) as a possible template for designing public systems in high-risk areas, emphasizing the importance of disaster risk reduction measures, including NbS, to reduce premiums. Additionally, considerations were made regarding the feasibility of parametric solutions tailored to wildfires, exploring the possibility of using proxy measures for risk assessment and insurance coverage.

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Key takeaways from the session included the promise of community-based insurance models in regions lacking comprehensive coverage, contingent on sustainable funding and stakeholder engagement. Moreover, the session underscored the pivotal role of NbS in wildfire risk reduction, necessitating robust assessment methodologies to instill confidence among insurers. Ultimately, the session highlighted the imperative for innovative approaches and collaboration to address the complex challenges of wildfire risk management and insurance coverage.

Innovating smart solutions to close the wildfire insurance coverage gap: parametric wildfire insurance?

Discussions on this topical question addressed parametric wildfire insurance as a potential solution to close the wildfire insurance coverage gap. The presentation focused on parametric forest insurance, which has been provided by WTW since 2017. The definition of parametric insurance differs from the traditional insurance products in that there is a pre-agreed index in the contract and payouts are triggered once the defined parameter is met or exceeded (as opposed to indemnity insurance where pay-outs are based on suffered losses, estimated during on-site inspections). Measurements of, among others, temperature, windspeed, moisture, are taken by independent providers. Since the scale of payment is agreed upon beforehand and the assessment process is accelerated by advanced technologies (e.g., satellite imagery), payouts are simpler and faster. The design of the contract is crucial, requiring an index that is suitable, robust and accurate in various aspects, to limit basis risk (i.e., the discrepancy between suffered loss and compensation).

It was remarked that parametric forestry insurance is often mis-concepted as a smarter way of measuring forest loss. The insured does not have to prove the damage and loss suffered to insured assets, enabling quicker assessment. An example in Chile is provided where the parameter was hectares of loss. Information can be applied to understand the basis of future risk. With data becoming increasingly available, reports of loss can be used by insurers in a practical way.

For the improvement of risk management processes, more changes in on-the-ground management are needed. The overarching challenges are: Who pays for the improvements in management? There can be significant cash flow constraints in forestry, especially where it is used as a nature reserve. Parametrics can fill the gap: by facilitating the ability to deploy insurance more cheaply and encourage improved management. But they do not fundamentally change the nature of the challenges of actually improving management practices.

Regarding how to incentivize NbS, a comprehensive programme would promote resilience of woodlands. Enabling recovery and NbS should also reduce future risk through proper management. The rights and interests of the contract buyers as private individuals and consumers should be projected. Another emphasis is on incentivizing governments to

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promote activities to share the risks more broadly, taking risks off the shoulders of the asset owners. In sum, more support and central intervention is desirable.

In the Q&A session, the following points were discussed:

- Differentiating pricing on what has been done to reduce hazard (e.g., through NbS). What are the impacts with and without practices like thinning? A plan for the process of how to make the forest insurable is needed.
- Transparency in data and pricing products. Parametric solutions are well-suited for other hazards, data sets used in contracts are transparent regarding magnitude and who is measuring. A correlation of the model to reference losses can be achieved.

How can and do insurers invest (divest) in nature?

This discussion featured the OECD's work on biodiversity and assessing nature-related financial risks. Introducing a three-phase approach to identify and prioritize the most relevant risks for financial materiality, it was suggested that risks stemming from biodiversity loss and broader nature degradation may lead to new financial risks as well as magnify those from climate-related risks. Feedbacks between the financial system and the economy may further aggravate these impacts, thus resulting in an important case for engaging in effective risk identification and prioritization.

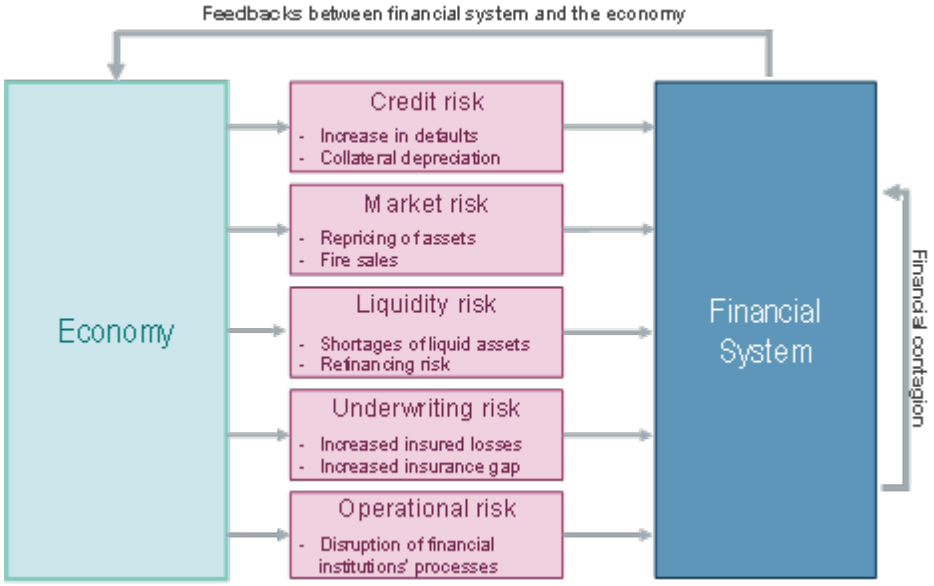

Figure 7: Overview of financial risk transmission channels (A Supervisory Framework for Assessing Nature-related Financial Risks)

The OECD is applying this model to the Hungarian financial system in cooperation with the central bank of Hungary. The approach will identify those sectors most exposed to biodiversity risks, then tie these risks back to lenders to firms in these sectors. This will inform the supervisory considerations for the central bank. They will also look at the double materiality issue, considering the impacts that firms have on nature themselves. This proceeds similarly by identifying the sectors most affecting nature, including real estate and

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manufacturing, which are therefore expected to be most exposed to transition risks as new regulations come into effect, and consumers want to shift away from firms and sectors that damage nature.

Risks can be assessed in view of how they affect the credit risk of firms, in terms of their probability of default on their loans and the potential for their collateral to depreciate. There have already been situations where severe droughts have led to major insurance losses, which required government intervention. The risk assessment approach is aligned with the Taskforce on Nature-related Financial Disclosures (TNFD) integrated assessment approach called LEAP (Locate, Evaluate, Assess and Prepare), which allows for diversifying risks across geographies.

The discussion highlighted that insurers are increasing their investments in nature, but not yet significantly into products that can support nature, other than a few selected pilots. There is a need for more general understanding among insurers and financial market players on what the risks from nature are. While there is much stated enthusiasm for nature-positive concepts, there is still insufficient knowledge on how to address them. The speaker noted that one opportunity for insurers is the Biodiversity Net Gain requirement being implemented in the UK, which requires new developments to more than offset any damage done to biodiversity. There is the potential for insurers to play a role in providing assurances that these offsets will be met, and stepping in to cover any missing offsets when they are not.

Incentivize wildfire NbS with differentiated pricing, even refusing cover for nature-negative projects

Implementing NbS to mitigate wildfire risks can be incentivized through premium discounts for households or communities that implement NbS. This would require policies for more general differentiated pricing according to the risk exposure of properties and assets, which can potentially encourage environmentally friendly and risk-reducing practices. Two existing programs illustrate how differentiated pricing, including discounts for DRR, can be applied: the National Flood Insurance Program (NFIP) Community Rating System and California's Regulation 2644.9 for wildfire insurance. Despite the structured approach, variability in premium reductions presents a challenge. Reductions range from 0.2% to 15%, with the most common being around 1.5%. This variability is due to differing interpretations and implementations of risk reduction measures by insurers. Some insurers may choose not to differentiate prices or withdraw from high-risk markets, complicating the regulation's effectiveness. NbS, such as prescribed burning and grazing by goats and sheep, are effective in reducing wildfire risks by maintaining landscape biodiversity and reducing fuel loads. Implementing NbS can be encouraged through insurance policies offering significant premium reductions for these measures. An audience member suggested that insurers could also refuse coverage for projects negatively impacting natural environments, promoting NbS adoption.

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Another participant added that Greece's recent legislation requires homeowners in wildfire-prone areas to certify their properties' fire preparedness, exemplifying another approach to integrating NbS into risk management. This law mandates homeowners to clear vegetation and maintain defensible spaces, potentially reducing insurance costs and enhancing community resilience.

This discussion also featured work related to the Fire-RES project on using differentiated insurance premiums to reduce wildfire risks. The speaker compared insurance with other economic incentives for wildfire mitigation, transitioning from theory to practical implementation. The presenter noted that reports from 2022 indicated abnormal burned areas during peak seasons. Europe, although less affected compared to places like California and Australia, still faces significant wildfire risks. Fuel accumulation in high-risk areas is a primary issue. In addition, he shared that landowners often need specific incentives for mitigation due to spatial contiguity, education, capacity to act, financial resources, and external risks. The presentation then discussed various incentive mechanisms such as environmental services markets, green bonds, and insurance. Sven further noted that case studies show the effectiveness of these mechanisms. For instance, a pastoralist program in the Canary Islands pays shepherds to graze specific areas to reduce shrub growth, highlighting targeted activities to maintain landscapes and reduce wildfire risks. He also noted that differentiated insurance can balance individual incentives and collective action. However, challenges include insufficient information on effective actions, high transaction costs, and the potential for inequitable outcomes. Extreme wildfire events may still overwhelm these measures. Stressing that European contexts differ from the US in settlement patterns, resistance to market-based logics, and reliance on public sector risk mitigation, he flagged that implementing strict suppression and mitigation measures might face public resistance due to the value of ecosystem services. Wunder then suggested that significant institutional reform at the EU level would require worsening wildfire damages to prompt change. He advocated for pilot actions in high-damage regions to test and learn about these mechanisms, rather than pushing for EU-wide recommendations prematurely. He emphasized the need for practical learning and adaptation based on pilot projects before scaling up these approaches.

A participant expressed concerns about inequalities in the U.S. community wildfire system and the rating system, particularly noting that some communities are less organized and may not benefit as much. Another participant added that this is a critical issue that needs to be addressed, emphasizing the importance of finding ways to support and enable these less organized communities.

How underwriters support wildfire risk reduction via NbS

In this discussion, questions were raised about how regulations can encourage a shift from conventional to nature-based solutions. It was noted that EIOPA is beginning to consider this. There was some caution expressed about the early stage of adopting NbS, while

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acknowledging the European Commission's directive to explore biodiversity's link to insured risks within a risk-based framework.

An audience member then inquired about where to find information on wildfire risks. The ongoing need for improved data and understanding of relevance to the insurance sector was emphasised, citing efforts to collect data on wildfire insurance claims and exposure. She mentioned that current models primarily focus on the US, with limited application in Europe due to data scarcity, relying on expert judgment in the absence of comprehensive data sets. Regarding regulations and policies for Europe, an audience member asked if there is a consolidated source. It was clarified that there isn't specifically for wildfires, highlighting a gap in comprehensive regulatory frameworks. A participant linked NbS to climate mitigation efforts, asking about incentives for low-carbon activities and the use of internal models for climate risks. Public consultations on dedicated prudential treatment related to fossil-related activities and potential adaptations were mentioned. It was noted that while standard formulas simplify risk reflection, internal models could enhance accuracy by considering adaptation measures, potentially reducing capital requirements.

Another participant added the slow integration of adaptation measures into models and criticized the TCFD for not emphasizing adaptation enough. She highlighted ongoing efforts within the EU Taxonomy and Climate Change Stress Test Directive (CCSD) to address adaptation. It was suggested that the insurance industry may not rapidly adopt NbS. Another participant mentioned Hungary's attempt to lower capital requirements for green loans but noted their limited share in overall lending. He stressed the need for balanced incentives. A final participant concluded by noting the uncertainty inherent in all models, particularly in human-dependent factors influencing wildfires in various regions.

What is the role of the EC and Member States?

The final presenter covered a study conducted with the European Commission to quantify wildfire risk and extreme heat impacts. Several key points were highlighted:

- The Commission currently doesn't collect systematic data on extreme heat impacts, like lost productivity and hospitalizations. Only Italy and Belgium collect some hospitalization data.
- The study focused on response costs for wildfires, using data from the Joint Research Centre (JRC). Key findings include: Significant wildfire damage in 2023, with €2 billion in Greece, €1 billion in Italy, and nearly €1 billion in Spain. The most significant year for wildfire losses was 2017, requiring a 70% increase in UCPM (Union Civil Protection Mechanism) funds to respond adequately. The EU Solidarity Fund (EUSF), intended for early recovery, has a significant time lag in disbursing funds, often taking months.
- There is an annual funding gap of €190 million for wildfire response, excluding indirect losses. Current instruments are insufficient for immediate relief and comprehensive risk management.

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- The absence of a fully probabilistic wildfire model limits accurate risk assessment. Existing models are under development, but none are comprehensive enough for robust predictions.

Regarding the recommendations, increasing budget allocations for both the EUCPM and the EU Solidarity Fund were suggested to better handle multiple major events in a single year. It may be possible to develop a risk transfer instrument attached to the Solidarity Fund to manage financial risks more effectively. Improve data collection on indirect impacts and establish probabilistic models for better risk management. It was also suggested to consider incorporating NbS and build-back-better principles into fund access requirements, similar to the now-defunct FONDEN in Mexico. The need for more specific equity measures and the potential for a scoring system to evaluate NbS contributions were also emphasized. The overarching recommendation is to include risk transfer mechanisms to enhance the EU's financial resilience against wildfires.

There was some agreement with this observation, and recognition of the shortcomings of the EUSF within the European Commission (EC) and the difficulty in implementing change due to the consensus-based governance model. The importance of exploring risk transfer mechanisms to manage disaster losses more effectively was emphasized, and the suggestion made that the Commission could support this by becoming a client for developing necessary models for insurers. It was noted that the EC could improve data collection and risk management regarding disasters like wildfires, advocating for a more proactive policy stance, particularly in assessing asset valuation and environmental impacts. There were doubts expressed about insurance being a favored option within the Commission, contrasting this with the more proactive stance of entities like EIOPA.

A participant then inquired about the uniformity of support from the EUSF across countries and whether it covers only public infrastructure damages or includes other recovery costs. Second, he questioned whether countries that insure their public infrastructure might receive less support, citing examples like France and Spain, and raising concerns about moral hazards. Lastly, it was asked to elaborate on why risk transfer mechanisms were considered preferable to simply increasing budget allocations or borrowing more to address funding gaps across various perils, including wildfires. In response to this, it was explained that the EUSF has clear rules for accessing funds, primarily aimed at reimbursing costs up to replacement value for reconstruction and equipment purchase related to disasters, with a recent expansion during COVID-19 to include health costs. Challenges in data reporting were highlighted, where distinctions between wildfire and drought are not always clear. Samantha emphasized the importance of risk transfer mechanisms as more cost-effective for managing extreme risks compared to relying solely on debt, noting the need for commercial interest or public-private partnerships in these endeavours. She also mentioned the complexities in financing and planning due to the multi-year budget cycles and the lack of integrated data for multi-hazard scenarios.

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A participant then flagged the tabled recommendation suggesting the European Commission should enhance the Solidarity Fund with a reinsurance instrument to provide subsidized reinsurance to national insurers, both public and private, thereby shifting from pure risk retention to risk transfer. Another participant agreed with the concept but noted the need for further exploratory work to substantiate the recommendation. A further participant raised concerns about Italy's fiscal challenges related to disasters and low insurance coverage, prompting Samantha to attribute these issues to data availability constraints.

A main outcome of the workshop was to table and discuss expert recommendations for national regulators, policy makers and the European Commission for incentivizing or otherwise supporting NbS for wildfire risk management through insurance mechanisms. The recommendations were voiced in terms of questions for consideration targeted to both national / EU regulators and the European Commission and Member States. They include;

For regulators

- California requires insurers to differentiate premiums to reflect DRR. Should EU regulators require differentiated pricing to reflect not only DRR, but NbS?
- Parametric insurance products are innovative solutions for wildfire, yet many countries do not allow them because the payout is not directly determined by loss. There is also little transparency in the pricing. Should national regulators make parametric products more transparent and control their pricing?
- The EU Taskforce on Nature-related Financial Disclosures (TNFD) recommends more transparency in insurance investing. Should regulators make the requirements mandatory (as in the UK).

For the European Commission and Member States

- Since wildfire risks are relatively uncorrelated across countries, there is potential for pooling across the EU. Should the EUSF be extended to provide subsidized reinsurance to MSs that take DRR-NBS measures?
- Since most NbS are carried out at the community scale, should the EU enable public community insurance programs, e.g., by reexamining the 2009 EU Directive abolishing public insurance monopolies?
- Should the Solvency II Directive be reformed to assure that investment policies reflect biodiversity goals of the EU?

When discussing these potential recommendations, participants agreed that they are worthwhile but that further specifications around the format and target group would be necessary. In addition, participants stated that while they are happy to be listed as participants in the WIIL, they would not support direct attributions of any recommendations to themselves or their organisations, noting Chatham House rules and procedural and hierarchical considerations.

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Vienna, Austria Session

The first session focused on the role of fire modelling in accounting for NbS. The FLAM wildfire model was presented, which is being used in a case study in Sardinia for the HuT project. This model incorporates data on climate, geography, fuel, and human settlements in order to estimate the likelihood of fire occurrence and estimates of burned area over time. The FLAM team is advancing the development of the model to work at high spatial resolution, while being able to estimate the likelihood of fire spread in order to better capture the most extreme fires within the model. They are also working to make it interoperable with additional data that can be brought to bear, which can include data on the existence of risk reduction measures, potentially including nature-based measures.

This was followed by a presentation on the development of a fire model in Europe that can be used for pricing parametric insurance products for wildfires. This is developed within the context of the Fire-Res project, for which a technical report on the methodology for such a product has been produced. This has involved focus groups in two communities, one in France and one in Spain. They revealed stark contrasts between the two regions, with much higher economic utilization of forest lands in the French community than in the Spanish, leading to much higher rates of insurance coverage in the French context. However, there are additional considerations that were revealed, such as the historical mistrust of insurance in Spain. In the French case, there is already some advanced risk modeling occurring among insurers, which is related to the much higher levels of insurance penetration in this market.

The discussion continued with a presentation on the French Meadows case in California. In this case, WTW is exploring the potential for ecological thinning of the forested area to reduce property risk, and therefore insurance premiums. WTW has developed the Willis Re Wildfire Score, which is approved by the California Department of Insurance for use in pricing wildfire insurance. They are updating this model to incorporate the reductions in risk that can be achieved using ecological forestry methods. They are also developing a wildfire risk index that can be used for pricing parametric insurance contracts in the state. If the treatments are implemented, the premium for the parametric insurance can be reduced by 20-40%.

Next followed an open discussion on parametric insurance, cantered on the recommendation developed at the previous meeting: “National and EU insurance regulators should proactively ensure transparent and equitable pricing of parametric insurance products, while also incentivizing DRR and the take up of nature-based solutions.” There was a discussion of who it may be appropriate for and in what contexts. It was noted that parametric products have been mainly developed for large forest owners who are making economic use of the forest, largely for timber, but with some applications for local public authorities who are also managing large forest areas. The topic of regulation was also discussed, with concerns about the potential for parametric insurance to be a back door for introducing lotteries or gambling. Potential ways to mitigate these concerns were

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discussed, including placing a cap on the load that can be placed on parametric products, increasing transparency of the estimated risk that insurers use to price parametric products, and the possibility of requiring a purchaser of a parametric product to have some level of insurable interest (as is the case in some countries).

The final session focused on the prospects for community insurance to support the adoption of NbS for wildfire. The presentation focused on the Firewise USA community program. The California Department of Insurance has recently required insurers to provide discounts to communities that participate in this program, which is designed to lower wildfire risk to community properties. While the program does not explicitly encourage NbS, it is an aspect that could be easily added into such a program. The number of Firewise USA sites has been steadily increasing, even before the adoption of this new rule. Initial analysis of the program indicates that it may be reducing the wildfire risks that these communities face, although more work will need to be done to see how this has translated into reductions in costs to insurers. Also in this session was a presentation on incorporating NbS for risk reduction into models of flooding, given that the flooding context has received much more attention from both insurers and policymakers than wildfires. Models show that NbS can effectively mitigate risks, but that most of the benefits accrue to the society as a whole, and therefore will likely require strong public investments for NbS to be implemented.

5.4 Reflection and conclusion

The Wildfire Insurance Innovation Lab addressed the question: **What innovative insurance products/systems can support nature-based solutions (NbS) for wildfire risk management?**

This question was explored in three separate meetings: Solsona, Spain; Nea Makri, Greece; and Vienna, Austria. The Lab was attended by experts from insurance companies and brokers, ecologists and forest managers, insurance regulators, academic researchers, and practitioners, among others.

The core WIIL question addressing how insurers can support NbS centred on three further questions, namely:

What is the current landscape of wildfire insurance across the Mediterranean and more broadly the European Union, and what are the gaps in coverage?

The WIIL reported a wide variation in levels of coverage with some countries (e.g., Italy) relying heavily on post-disaster government relief. Insurance provision ranges from primarily public (e.g., Spain and Norway) to wholly private provision (e.g., Germany) with some countries supporting hybrid public-private systems (e.g., France). It appears that no insurance system has built in strong incentives for wildfire risk mitigation.

What are nature-based solutions for wildfire mitigation in different landscapes?

The WIIL discussions proved this question to be controversial. Competing perspectives on wildfire NbS show a trade-off between reducing wildfire risk, e.g., with forest thinning,

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prescribed burns and/or animal grazing to reduce fuel load, and promoting biodiversity, e.g., by rewilding, re-wetting and allowing deadwood to accumulate on the forest floor. The consensus was 'no one NbS fits all' and it will depend on the landscape, e.g., wilderness, abandoned farmland or urban-wildland interface, as well as on the context, e.g., shrub, grasslands, boreal forests, etc.

How can insurance support NbS?

Discussions in the WIIL led to the development of a taxonomy of insurer activities for enabling NbS, including the underwriting and investment sides of the business. Underwriting activities include offering cover for NbS loss and damage (e.g., coral reefs), de-risking NbS operations (e.g., prescribed burns), incentivizing NbS with insurance pricing (e.g., buffer strips), enabling NbS financing (e.g., debt for nature swaps), and declining cover for nature-negative projects (e.g., the African crude oil pipeline). In addition, insurers have large investment portfolios that they can make more transparent and directly support NbS with nature-negative divestment, nature-positive investment, and philanthropic NbS investment.

The WIIL concluded with innovative ideas for wildfire insurance products and systems that can support NbS. Six key innovations emerged as ideas for further exploration:

- Close the wildfire protection gap with 'smart' public/private strategies that prioritize disaster risk reduction and nature-based solutions. Vulnerable populations often bear the brunt of wildfire disasters but may lack the financial resources to recover adequately. Closing the protection gap can help level the playing field and ensure equitable access to post-disaster funding for more resilient recovery. There is no one 'best' way to provide protection, which can include a mix of public assistance and public, public/private and fully private insurance systems. The challenge is to provide inclusive protection and at the same time set incentives for taking loss-reduction measures. The following innovations are targeted towards designing 'smart' protection strategies that both promote NbS and support equity in the sharing of losses from wildfires.
- Explore community-based wildfire insurance. Many wildfire risk reduction measures, and especially nature-based measures, require actions beyond those of individual households to actions at the community scale. An important example is the US National Flood Insurance Program (NFIP), which emphasizes affordability and access to flood insurance for participating communities. One notable aspect is the Community Rating System (CRS), which provides premium discounts to households based on the implementation of risk reduction measures by the community. The integration of NbS within the CRS, such as open space preservation and natural stormwater management, highlights their potential for community-based wildfire insurance programs. Transferring the NFIP approach to the European Union context would need tailored strategies that fit more easily with public insurance systems that are prevented by the EU prohibition on public insurance monopolies. These legal constraints should be clarified, both at the EU and member state level, and opportunities explored for insurance systems that can promote NbS.

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- Reduce premiums on parametric wildfire insurance products based on NbS measures in place. Parametric insurance is an innovative approach for providing protection against wildfire losses. It is available and in use in many parts of the world, including in Europe, but it does not generally incorporate risk-reduction measures, nor does it incentivize nature-based measures. The WIIL explored the potential for wildfire parametric products to incorporate risk reduction by investigating current modelling efforts by WTW, MITIGA and IIASA, which show a great deal of promise in taking account of certain types of wildfire NBS measures. While there is some potential for private markets to develop and market nature-positive parametric products, it will likely require policy changes in order to be widely adopted. To allay concerns about the potential for insurance companies to take advantage of consumers, suitable regulations could be put in place, including the adoption of the insurable interest principle, as well as requiring greater transparency, or placing some controls on pricing.
- Differentiate wildfire insurance pricing to account for NBS as a measure for disaster risk reduction. A closely related innovation concerns the mandate of EU regulators, who might consider placing priority on promoting disaster risk reduction and NBS by requiring differentiated pricing, e.g., with discounts for NBS. As a case in point, the California Department of Insurance has recently required insurers to provide discounts to communities that participate in this program, which is designed to lower wildfire risk to community properties. While the program does not explicitly encourage NbS, it is an aspect that could be easily added if implemented in the EU.
- Reform the EU Solidarity Fund to encourage Member States to invest in NBS. Based on the UNCDF, which provides cities and other sovereigns in the developing world with affordable climate insurance with pre-arranged premiums and premium discounts for DRR, another innovation emerging from the WIIL is reform of the EU Solidarity Fund that currently provides ex post relief to Member State governments after major disasters. The EUSF ex post compensation mechanism might be complemented by a reinsurance instrument with conditions for DRR / NBS. Indeed, given the relatively limited correlation between wildfire occurrences across EU countries, there is potential for leveraging diversification and risk pooling advantages on a European Union (EU) scale.
- Move towards mandatory implementation of the TNFD. In 2023, the Taskforce on Nature-related Financial Disclosures (TNFD) released recommendations for companies to identify and disclose nature-related issues, which will assure more transparency in the investment portfolios of insurers. Corporate impacts on biodiversity underlie many of the TNFD's recommendations, which are currently voluntary. However, many are calling for mandatory requirements, which could be implemented by the European Commission. Disclosure, however, would only be a first step, as once the impacts of companies are better understood, there could be further regulations incentivizing investment and divestment actions to support a nature-positive economy.

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Participants agreed that these innovations have the potential to promote NbS, but not all agreed that the innovations should map into recommendations. It was agreed that there would be no direct attribution of any recommendation to participants or their organisation.

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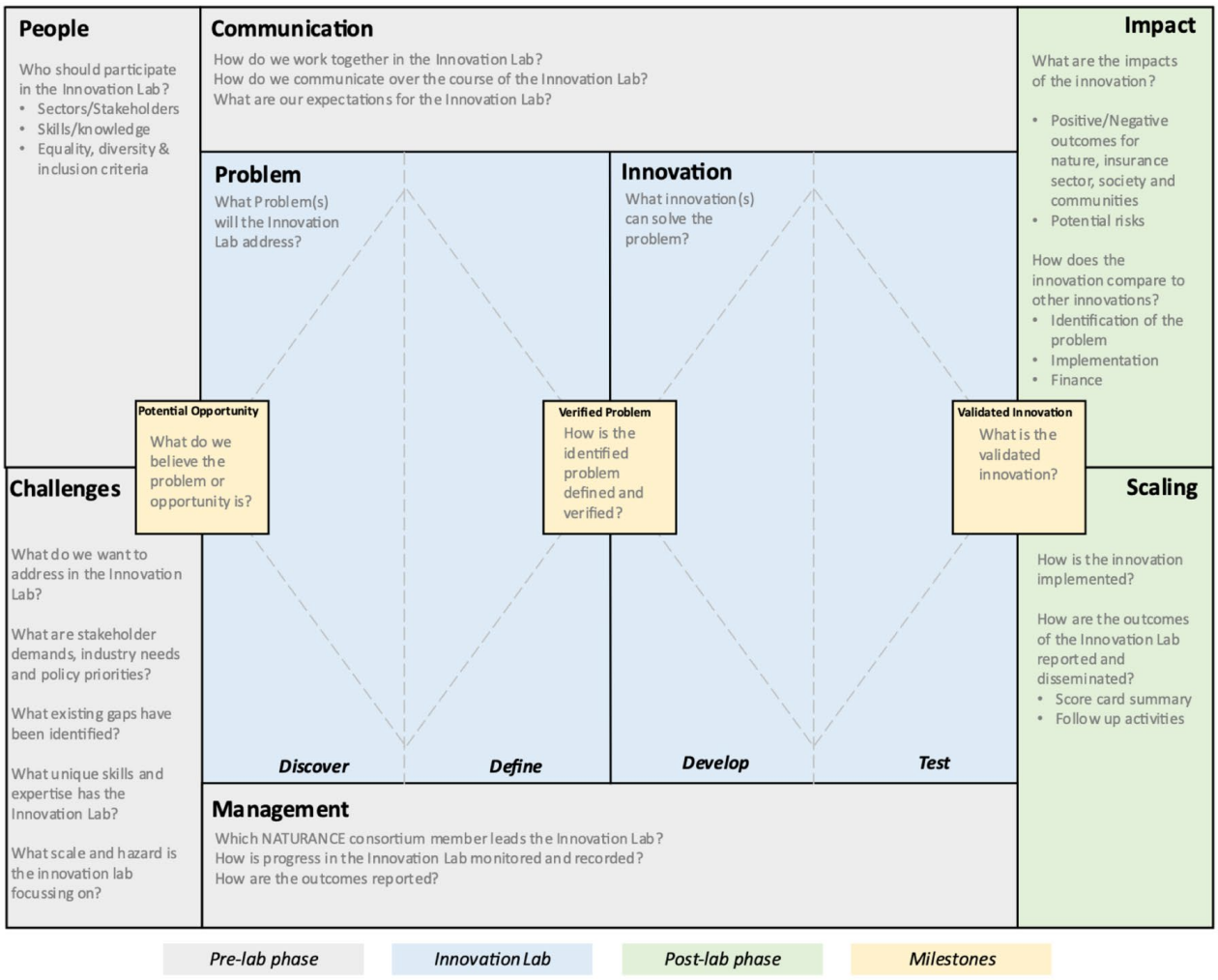
7 Appendix

See a complete version of the appendix on the NATURANCE website: www.naturanceproject.eu

7.1 Innovation Lab Canvas



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7.2 Business Case Summary

	Summary	Scale (1 to 5, 0 in case question cannot be assessed)	Score
Problem statement, Current baseline & Innovation	How well does the developed business case: - Identify the challenge/need for innovation regarding the link between nature and insurance? - Provide a solution to the identified challenge? - How new and innovative is the developed business case solution?	1 (Significantly below current standard/ baseline) 5 (Significant improvement to current standard baseline)	x/15
Implementation & Execution	How well does the developed business case (max. 5 points per question): - Identify the key groups and stakeholder that are needed for implementation? - Outlines the implementation strategy? - Outlines and addresses risks surrounding the implementation?	1: Makes implementation very unlikely 5: Makes implementation very likely	x/15
Finance	How well does the developed business case (max. 5 points per question): - Demonstrate the ability to get financed? - Describes the need, use and source of funding? - Outlines sustainable financial expectations?	1: (Does not at all contribute to getting financed) 5: (Does significantly contribute to getting financed)	x/15
Impact	How well does the developed business case (max. 5 points per question): - Show how the innovation can lead to a positive impact for nature? - Show how the innovation can have a positive impact for the insurance sector? - Show that the innovation can lead to a positive impact for society and communities including climate resilience, equity and participation?	1 (No or negative impact) 5 (Highly significant impact)	x/15
Total			x/60

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