HORIZON 2020

Coordination and support actions

Thinknature

Development of a multi-stakeholder dialogue platform and Think tank to promote innovation with Nature-based Solutions

WP4 – Establishment of the ThinkNature multi-stakeholder innovation platform for NBS

Deliverable 4.4


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Executive summary

The aim of Work Package (WP) 4 Dialogue Steering for the NBS (Nature-based Solutions) Innovation Domains is to engage relevant stakeholders through dialogue steering activities (brainstorming forums and debates) and use the ThinkNature Platform in order to: 1) Identify relevant NBS and assess their potential, 2) explore the scope for replication and/or scaling up of successful NBS, and 3) facilitate the collection and sharing of knowledge on NBS in relation to set priority areas.

This Report on Dialogue Steering Statement Papers and Dialogue Outcomes provides a detailed description of the procedure and the outcomes of the work performed within the domain of Risk Management and Resilience, which is one of the four priority areas identified in order to structure the discussion on NBS and focus on the related benefits, while ensuring opportunities to link with relevant experts. The other three set priority areas are: sustainable urbanisation in cities, restoration of degraded ecosystems; climate change adaptation and mitigation.

In the context of reaching the objectives of WP4, within the priority area of Risk Management and Resilience, five Innovation Working Groups (IWG) were established (with members within the ThinkNature Consortium) to explore further the identified topic areas. Following the literature review performed within each of the five IWG an internal synthesis of the issues to be addressed was produced. The next step was to create a short list of topics to be analysed. It was decided that the identified topic areas would be explored in greater depth during the Paris Forum on NBS (4th and 5th April, 2019). Three main topics were further elaborated during the Paris Forum:

- Combining NBS as an integrated approach for risk management and resilience
- NBS for risk management across scales: synergies from local to city and regional level
- Innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation

This event, apart from supporting knowledge gathering and exchange on NBS, also facilitated the engagement of relevant on-going demonstration H2020 projects, allowing them to participate in the stakeholder dialogue. The local and regional stakeholders who were identified through WP3 procedures (Local Representatives and Regional Think & Do Tank members) were also included in this process and had a good representation in the Paris Forum.
In addition to a wide range of detailed conclusions, the dialogue outcomes on Risk Management and Resilience include the following key messages for each topic:

Combining NBS as an integrated approach for risk management and resilience

- A wide consensus on NBS definition and the formulation of global NBS standards are important conditions for mainstreaming NBS in the strategies for risk management and resilience
- Transition from top-down to bottom-up decision making and the implementation of participatory processes is needed for the facilitation of NBS uptake
- Large scale (i.e. beyond the urban boundaries) integrated solutions that combine green and grey systems and rely on biodiversity are the key concepts for holistic risk management and resilience

NBS for risk management across scales: synergies from local to city and regional level

- Vulnerability mapping should be among the top priorities
- Maturity of society is needed in order to implement NBS instead of grey solutions
- There is a difficulty in integrating knowledge and approaches from experts with various skills and expertise

Innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation

- Holistic NBS monitoring and impact evaluation is challenging due to the multiple (environmental, social, economic) and multi-scale (temporal - spatial) NBS benefits that are not yet clearly defined or fully recognized
- There are several technological, technical and knowledge gaps in the available monitoring methodologies for NBS impact evaluation that can be overcome by exploiting state-of-the-art technologies
- Technological advances in modelling capabilities, Earth Observation, data and citizen science are very promising and can be used as tools for achieving a complete NBS monitoring and evaluation framework
The stakeholder dialogue was also facilitated in a special section of the ThinkNature Platform during the whole project duration, which supported the main topic definition, the knowledge and the policy gaps on this domain. The dialogue on the ThinkNature Platform continues, as the main outcomes of the Paris Forum are posted gradually as separate threads to stimulate more idea exchange and gather feedback from the NBS community. The final outcomes of the dialogue conducted in the framework of WP4 will be included in a concise and consolidated form in the ThinkNature Handbook for NBS (WP6).
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1 Introduction

1.1 State-of-the-art on risk management and resilience through NBS

Risk management and resilience is a quite contemporary objective, included more and more frequent in planning towards achieving a long-lasting state of sustainability. In general, resilience is not a new term, since it has been used differently (ecology, sociology, etc.) in many several contexts throughout centuries, resulting in various interpretations (Alexander, 2013). A definition, which can be broadly used, describes it as “the intrinsic capacity of a system, community or society predisposed to a shock or stress to adapt and survive by changing its non-essential attributes and rebuilding itself” (Manyena, 2006, p. 446). On the other hand, risk is “probability based, defined by the probability and severity of adverse effects (i.e., the consequences)” (Aven, 2011, p. 515).

Nature can have a major impact on disaster risk reduction and on increasing resilience through its inherent adaptive and evolutionary attributes. Ecosystems, in their natural healthy state, are by default self-sustainable and present enormous capabilities of resisting and recovering after external disturbances, as well as adapting to new conditions. Thus, healthy ecosystems are crucial for risk management and resilience on two levels: for prevention and post-disaster recovery, in fact for every step of disaster management. By embedding nature in disaster management planning, it is possible to reduce the hazard impact from becoming a disaster.

Risk management and resilience enhancement is set by the EC as one of the four main goals that can be achieved with NBS (EC, 2015). Through NBS, synergies in reducing multiple risks are offered. Synergies and interactions, when addressing risk management and resilience using NBS, include all 4 pillars of Sustainability (Environment, Society, Economy and Culture) and should at all times be taken into account. As such, using NBS (e.g. a wetland) to achieve risk management and resilience very often leads to greater benefits than conventional methods (e.g. a water treatment plant). For example, urban green infrastructure aiming to increase resilience, creates social and environmental benefits among which: social cohesion, reduced flood damage, improved water quality, recreational facilities, improved wellbeing, etc. On the other hand, among the various economic benefits, the
following are included: increased productivity, increased land value and retail sales, income generation, reduced energy cost, etc. (Arup, 2014).

There is increasing momentum for the use of NBS as part of resilience-building strategies, sustainable adaptation, and disaster risk management strategies of the EC and other international organizations. Awareness of NBS from communities, donors, and policy- and decision-makers is also growing. Furthermore, investors and the insurance industry are increasingly interested in NBS (EIB, 2019; World Bank, 2017). From a climate change perspective, ecosystem-based adaptation has been highlighted as a priority investment area in global funds such as the Global Environment Facility or the Green Climate Fund. According to IUCN (Cohen-Shacham et al., 2019), ecosystem-based adaptation approach falls under the NBS umbrella with three other ecosystem approaches, such as forest landscape restoration, ecological restoration and protected areas.

Fortunately, the policy context over the past years has evolved to include ecosystem-based strategies for Risk Management and Resilience and Climate Change Adaptation and Mitigation, although more progress is still needed. The latest IPCC Special Report on Extreme Events (SREX) report lists investing in ecosystems as “low-regrets” measures alongside early warning systems; risk communication between decision makers and local citizens; sustainable land management, including land use planning; and ecosystem management and restoration (IPCC, 2012). The 2011 and 2009 Global Assessment Reports (UNISDR, 2009; 2011) listed environmental degradation as one of the main drivers of risk. During the course of United Nations Framework Convention on Climate Change (UNFCCC) negotiations for a global climate agreement and in particular since the Conference of Parties (COP) in Copenhagen in 2009, ecosystem-based approaches have been recognized as a key Climate Change Adaptation strategy.

The World Bank (https://naturebasedsolutions.org/) recommends that adaptation programs integrate NBS into vulnerability and Risk Management and Resilience strategies. The World Bank’s Nature-based Solutions Program and World Bank projects are already investing in NBS components. From 2012 to 2018, the World Bank’s disaster risk management portfolio totalled US$52.87 billion across 681 projects. Over this same period, the World Bank approved 76 disaster risk management projects that utilize NBS in project subcomponents. Moreover, the World Bank NBS Program has been exchanging knowledge, experiences, and lessons
learned among stakeholders to enhance the planning and implementation of NBS across the World Bank portfolio (Browder et al., 2019; World Bank, 2017).

The EU has also developed significant synergies with relevant UN bodies in order to place NBS on the agenda of Convention on Biological Diversity: Subsidiary Body on Scientific, Technical and Technological Advice (CBD/SBSTTA), United Nations Convention to Combat Desertification (UNCCD), UNFCCC, Sendai framework, United Nations International Strategy for Disaster Reduction (UNISDR), Partnership for Environment and Disaster Risk Reduction (PEDRR), Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and the UN Habitat III new urban agenda. In particular, the EU has played a key role in the dialogue of three global agreements:

1. The **Paris Agreement (2015)** - The Paris Agreement reports the importance of ensuring the coherence of all ecosystems and supports the role of adaptation in protecting livelihoods and ecosystems. The Paris Agreement, regarding climate change, provides an opportunity for countries to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius (UN, 2015).

2. The **New Urban Agenda (2016)** - The New Urban Agenda (Habitat III) refers to nature-based innovation for urban and territorial planning (UN, 2017). NBS and other ecosystem-based approaches have also been promoted in decisions of the UN Convention on Biological Diversity relating to restoration of biodiversity, climate change and mainstreaming biodiversity (UNEP, 2016).

3. The **Sendai Framework for Disaster Risk Reduction** (Estrella et al., 2016) - The Sendai Framework 2015-30 aims at the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

EU’s most progressive directives for integrating ecosystem management with disaster risk reduction is the **Water Framework Directive** (EC, 2000), which was enacted in 2000. The Water Framework Directive in particular supports an integrated approach to water and drought risk management, implemented through its member states. It is one of the few directives with a dual ecological and disaster risk
reduction component, requiring that ecological standards be upheld for water management measures,
1.2 NBS Case Studies’ portfolio on risk management and resilience

There are numerous case studies around the world, where NBS have been successfully implemented to address such risks. In most cases, large scale (i.e. beyond the urban boundaries) integrated solutions are more effective to holistic risk management and resilience. In several cases, the integration of green and grey systems is considered important for the efficient and successful large scale implementations. In Table 1, the regulating services for hazard mitigation from some exemplary NBS are provided. The scale of interventions can vary, as can the strategies adopted to address resilience and different types of risks through NBS. Indeed, NBS can improve conditions and the resilience of ecosystems and their services, whether aiming to enhance urban resilience, climate, water or coastal resilience, depending on the context and the addressed challenges. In all cases, resilience interrelates with adaptability and transformability across scales. (Folke et al., 2010). The implications and interactions of different spatial scales are a very important aspect. NBS allow working on different scales, through different approaches and techniques, starting from building level, to local scale and then to regional scale.

Depending on the scale of the intervention, NBS successfully address many climate related risks e.g.: Heat island effect, extreme cold, river floods, surface water floods, coastal floods, water scarcity/ droughts, water quality, fire risks, landslides, storms, etc. Specifically, NBS are considered very effective in the prevention and reduction of fluvial and pluvial flooding, coastal flooding, landslides and drought (e.g. Browder et al., 2019). The ThinkNature case study portfolio contains multiple highlighting examples where NBS is used to address risks and improve system resilience (Appendix 1). It is demonstrated that using NBS to achieve risk management and resilience, very often leads to greater benefits than conventional methods. Moreover, through NBS, synergies in reducing multiple risks are offered. In 63.6% of the case studies of the ThinkNature Portfolio, improving risk management and resilience is the reported principal goal addressed by NBS (Figure 1). This is clearly highlighted in the 10 case studies overviewed in the Appendix. The scale of interventions varies, as does the location and the strategies adopted to address resilience and different types of risks through NBS. Indeed, the innovative Nature-based Solutions of the highlighted case studies follow various approaches to improve conditions and highlighted case studies follow various approaches to improve
conditions and resilience of ecosystems and their services, whether aiming to enhance urban resilience, climate, water or coastal resilience, depending on their context and the addressed challenges. In all cases, resilience interrelates with adaptability and transformability across multiple scales (Folke et al., 2010).

Technical and knowledge barriers, as well as various governance and legislative barriers are identified to impede the successful implementation and replication of NBS for Risk Management and Resilience. The challenge is to successfully address those barriers and ensure the wide uptake of such interventions.

Figure 1. Statistics on the four principal NBS goals addressed by the case studies of ThinkNature portfolio (Nikolaidis et al., 2019).
<table>
<thead>
<tr>
<th>Nature Based Solution</th>
<th>Impacts on hazard mitigation</th>
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<tbody>
<tr>
<td>Maintain and enhance natural wetlands</td>
<td>Flood control in inland river basins, coastal areas and mountain areas subject to glacial melt. Water storage and slow release, reducing the speed and volume of runoff after heavy rainfall or snowmelt in springtime.</td>
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<tr>
<td>Restore wetlands in areas of groundwater recharge</td>
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<tr>
<td>Reconnect rivers with floodplains to enhance natural water storage</td>
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<tr>
<td>Floodplain restoration and management</td>
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<tr>
<td>Protect remaining intertidal muds, saltmarshes and mangrove communities, seagrass</td>
<td></td>
</tr>
<tr>
<td>beds and vegetated dunes from further degradation, fragmentation and loss</td>
<td></td>
</tr>
<tr>
<td>Mangrove forests protected area</td>
<td>Reduction of the height and speed of storm surges and tidal waves. Protection against hurricanes, storm surges, tsunami, flooding and other coastal hazards. Absorption (low-magnitude) of wave energy, reduction of wave heights and reduction of erosion from storms and high tides. Saltwater intrusion avoidance and adaptation to (slow) sea-level rise by trapping sediment and organic matter</td>
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<td>Enhance or facilitate habitat expansion, including the facilitated range expansion of</td>
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<td>mangroves, as warming conditions and changes in storm occurrence permit</td>
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<tr>
<td>Create new intertidal habitat through afforestation, or planting of saltmarsh or</td>
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<td>seagrass at appropriate elevations in the tidal frame</td>
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<td>Re-establish and restore previous intertidal habitat by de-poldering or coastal</td>
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<td>Ecological restoration of degraded coastal and marine ecosystems</td>
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<td>Coastal sand engine</td>
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<td>Dune replenishment</td>
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<tr>
<td>Protect forests from clearing and degradation from logging, fire and unsustainable</td>
<td>Reduction of erosion and increase of slope stability by binding soil together, preventing landslides. Prevention of rockfall and stabilisation of snow reducing the risk of avalanches. Flood risk reduction by increasing infiltration of rainfall, and delaying peak floodwater flows, except when soils are fully saturated. Water recharge and purification, drought mitigation and safeguarding drinking water supply for some of the world’s major cities.</td>
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<tr>
<td>levels of non-timber resource extraction</td>
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<td>Systems for erosion control</td>
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<tr>
<td>Soil and slope revegetation</td>
<td></td>
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<tr>
<td>Strong slope revegetation</td>
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<tr>
<td>Plant trees/ hedges/perennial grass strips to intercept surface run-off</td>
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<tr>
<td>Large urban park</td>
<td>Urban flooding prevention by capturing runoff from upstream basins and adjacent areas</td>
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<tr>
<td>Urban forest</td>
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<tr>
<td>Intensive green roof</td>
<td>Reduction of stormwater runoff by promoting rainfall infiltration on the tops of buildings. Green roofs retain 50 to 100 % of the stormwater they receive.</td>
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<td>Semi-intensive green roof</td>
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<td>Extensive green roof</td>
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2 Methodology

2.1 Identification of the topic priority areas

Five Innovation Working Groups (IWG) were established (with members within the ThinkNature Consortium) during the first months of the project to explore the priority topic areas regarding the Risk Management and Resilience (Figure 2). The initial topic areas, as defined by the ThinkNature (TN) proposal (Grant Agreement number 730338), were:

- Combining nature-based solutions for risk management in various levels (such as reduction of pollution, carbon storage, preservation of biodiversity, recreational activities, and economic opportunities).
- How to offer synergies in reducing multiple risks in regional level. How the risk management in local level influences regional and EU level.
- How to leverage funds for long term benefits and to ensure massive involvement of politicians and private companies in the implementation and funding of such solutions.
- How promoting ecosystem-based solutions is in itself an innovative way to consider risk management as an integrated approach, combining different scales and planning perspectives.
- Robust monitoring of the performance and assessment of the impact of deployed NBS

Figure 2 demonstrates the process of establishing the IWG within the ThinkNature consortium. Per each of the 5 topic areas (grey column) one organisation from the ThinkNature consortium has been assigned (blue column) to be responsible. Such organisation was named as a Content Creator (CC), an entity responsible for the topic area linked to the activities such as research, content development and stakeholder identification. In addition to that, CC was responsible to identify and invite the most relevant stakeholders to participate in steering activities (dialogues, BFs) and sharing of experience and knowledge through case studies and other resources via ThinkNature Platform.
Figure 2. The structure of the 5 Innovation Working Groups (IWG) to explore the priority topics for the challenge of Risk Management & Resilience

Subsequently, under WP3, through the identification and engagement of local and regional stakeholders (Local Representatives and Regional Think&Do Tanks), the IWG were enlarged by the local and regional experts via interactive dialogue, collection of case studies, online and face to face meetings to further speed up the development of the topic areas. In order to support CC, other organisations from the consortium were assigned to help CC to develop content and assist with related work. These organisations were called Contributors, marked by a green dot (Figure 2). They were selected based on their experience and expertise. After the IWG had been established, CC and Contributors started to develop more specific content under each of the 5 topic areas by breaking each of the topic area down into 4-6 sub-topics/actions (Table 2).

An internal synthesis of the issues to be addressed was implemented towards the definition of the content that would be discussed in the special session for Risk Management and Resilience of the Paris Forum. All the identified priority areas for discussion were clustered in three major issues that defined the themes of the three parallel sessions of Paris Forum focussed entirely on Risk Management & Resilience (Table 3). Topic 3 (Table 2) was integrated in a separate dialogue of the Paris Forums, that was focused explicitly on NBS Financing, Business Models and Decision-Making. The description and outcomes of this dialogue are included in the respective ThinkNature Deliverables D7.2: Analysis of the business case for the application of the nature based solutions and D7.3: Report on the market potential through synergies in International level (https://platform.think-nature.eu/project-deliverables).
Table 2. Breakdown of the initial five topics to different actions by the Innovation Working Groups (IWG).

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<td><strong>Topic 1</strong> Combining nature based solutions for risk management in various levels such as reduction of pollution, carbon storage, preservation of biodiversity, recreational activities, and economic opportunities.</td>
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<td><strong>Action 1</strong> List the major risks that Europe is exposed to and can be mitigated using NBS. Categorize the risks according to their severity and target area (e.g. urban, rural). Indicate the differences in the susceptibility of each Regional Area to each risk.</td>
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<td><strong>Action 2</strong> Identify the already implemented and novel NBS concepts for Risk Management and Resilience. Categorize NBS according to their suitability for each risk or risks. Indicate the effectiveness of the NBS (if already reported) and the differences in the regional level (if any).</td>
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<td><strong>Action 3</strong> Identify the combined benefits of each NBS and their connection to risk management.</td>
</tr>
<tr>
<td><strong>Action 4</strong> Exploration of the limitations of the NBS in Risk Management and Resilience and compare it with the more conventional method (if any).</td>
</tr>
<tr>
<td><strong>Topic 2</strong> How to offer synergies in reducing multiple risks in regional level. How the risk management in local level influences regional and EU level.</td>
</tr>
<tr>
<td><strong>Action 1</strong> Investigation of the advantages of the multifunctional solutions for Risk Management and Resilience. How can the multiple benefits of local scale NBS (e.g. carbon sequestration) impact the regional and EU scale?</td>
</tr>
<tr>
<td><strong>Action 2</strong> Exploration of new approaches in NBS for Risk Management and Resilience.</td>
</tr>
<tr>
<td><strong>Action 3</strong> Identify the harmonization of NBS for Risk Management and Resilience with EU regulations.</td>
</tr>
<tr>
<td><strong>Topic 3</strong> How to leverage funds for long term benefits and to ensure massive involvement of politicians and private companies in the implementation and funding of such solutions.</td>
</tr>
<tr>
<td><strong>Action 1</strong> Explore the cost-effectiveness of NBS for risk management compared to the conventional methods. What financial added benefits or opportunities can arise from the different NBS applications in the short and long term?</td>
</tr>
<tr>
<td><strong>Action 2</strong> Explore the emerging decision support tools and financial instruments for promoting NBS in risk management and resilience.</td>
</tr>
<tr>
<td><strong>Action 3</strong> Investigation of existing and new innovative concepts for introducing the insurance value of ecosystems.</td>
</tr>
<tr>
<td><strong>Action 4</strong> The role of ThinkNature as and evidence base for the dissemination of the NBS benefits.</td>
</tr>
<tr>
<td><strong>Topic 4</strong> How promoting ecosystem-based solutions is in itself an innovative way to consider risk management as an integrated approach, combining different scales and planning perspectives.</td>
</tr>
<tr>
<td><strong>Action 1</strong> NBS as part of a range of measures and actions from an integrated risk management perspective.</td>
</tr>
<tr>
<td><strong>Action 2</strong> Investigation of the multiple scale approach in NBS application and impact. The concept of scale in urban resilience and risk management.</td>
</tr>
<tr>
<td><strong>Topic 5</strong> Robust monitoring of the performance and assessment of the impact of deployed NBS.</td>
</tr>
<tr>
<td><strong>Action 1</strong> Investigation of the technical and scientific advances (e.g. models, methods, systems) in analyzing the performance of NBS in risk reduction and resilience.</td>
</tr>
<tr>
<td><strong>Action 2</strong> Methods and indicators for the quantification of the impact and the effectiveness of NBS in Risk Management and Resilience.</td>
</tr>
<tr>
<td><strong>Action 3</strong> The role of Earth Observation (EO) in monitoring NBS performance and impact towards risk reduction and resilience.</td>
</tr>
</tbody>
</table>

2.2 Content development for the Paris Forum on NBS

Table 3 summarizes the identified topics for discussion in the Paris Forum on NBS regarding Risk Management and Resilience. The content and session format development regarding these topics were assigned to specific members of the
already defined IWG (session leaders) according to the specific Paris Forum session format. Each session leader was called to complete the session template form (Figure 3) and address the following issues:

- Topic area
- How does the session contribute to the topic area?
- Speakers
- Targeted Audience
- Format and structure of the session
- How do you think the session can help scale-up NBS?
- What are expected deliverables?
- Which stakeholders will be able to use the deliverables and in what way?

The session format for each Paris Forum session was participatory and each session leader designed the structure of the session according to the needs for the dialogue of each session. The methodologies of Focus Groups (Slocum, 2003) and World Café (Brown, 2002) were recognized as the most prominent for the goals of Paris Forum dialogue. Most of the sessions adapted the Focus Groups methodology and modified it to meet the objectives of each session.

The following subchapters describe in detail the session content and structure of the 3 parallel sessions regarding Risk Management and Resilience, held during the Paris Forum on NBS (4 - 5 April 2019).

Table 3. Final topics for the three parallel sessions of Paris Forum focussed on Risk Management & Resilience.

<table>
<thead>
<tr>
<th>Risk Management and Resilience Topics for NBS Forum</th>
<th>Question 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combining NBS as an integrated approach for risk management and resilience</td>
<td>What is the greatest hazard potential in Europe and what are the related existing policies (EU to regional level) and tools for risk mitigation?</td>
</tr>
<tr>
<td>Question 2</td>
<td>Which are the most prominent NBS approaches/practices (or combinations of them) for risk management and resilience?</td>
</tr>
<tr>
<td>Question 3</td>
<td>Who are the stakeholders involved and what are the decision-making mechanisms in defining the strategies for risk management?</td>
</tr>
<tr>
<td>Question 4</td>
<td>What would be alternative decision-making mechanisms to facilitate NBS uptake in risk management &amp; resilience?</td>
</tr>
<tr>
<td>Question 5</td>
<td>What is the current status of involving NBS (or ecosystem-based strategies) in the EU and regional policy context?</td>
</tr>
<tr>
<td>Question 6</td>
<td>How to facilitate uptake of NBS in the strategies for risk management and resilience at diverse spatial levels?</td>
</tr>
</tbody>
</table>

**Session 2**  
NBS for risk management across scales: synergies from local to city and regional level

| Question 1 | How can we prioritise decision making among scales before and after disasters? |
| Question 2 | How can urban infrastructure become regenerative over time, taking into consideration scale? |
| Question 3 | What are the foundations for creating resilience and which can be new approaches for future proof city planning? |
| Question 4 | How to keep actors and stakeholders engaged and ambitious through the entire process of a complex spatial project? |

**Session 3**  
Innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation

| Question 1 | What are the most critical requirements of the methodologies in order to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience? |
| Question 2 | Are there available monitoring methodologies or indicators to evaluate NBS contribution to risk management and resilience? |
| Question 3 | Explore and suggest new tools and infrastructure that meet the recognized critical requirements to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience |
| Question 4 | Explore and suggest approaches for indicator development, data standardization and methodology harmonization for improving NBS assessment schemes towards risk management and resilience |
HORIZON 2020
Coordination and support actions

Development of a multi-stakeholder dialogue platform and Think tank to promote innovation with Nature based solutions

WP4:
Session Template
Paris Brainstorming Forum 4-5 April 2019

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 727331.

November 2018

Actions on the regional and local levels. What can ThinkNature do – the Platform, the regional ThinkNets, Paris and the Local Representatives?

<table>
<thead>
<tr>
<th>Name of speaker</th>
<th>Job title</th>
<th>Stakeholder type (as defined in the proposal)</th>
<th>Institution</th>
<th>Region (as defined in the proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Actions on the regional and local levels. What can ThinkNature do – the Platform, the regional ThinkNets, Paris and the Local Representatives?

What are expected deliverables (approx. 200 words)

Actions on the regional and local levels. What can ThinkNature do – the Platform, the regional ThinkNets, Paris and the Local Representatives?

Which stakeholders will be able to use the deliverables and in what way? (approx. 100 words)

Actions on the regional and local levels. What can ThinkNature do – the Platform, the regional ThinkNets, Paris and the Local Representatives?

Figure 3. Paris Forum Session template form.
### 2.2.1 Combining NBS as an integrated approach for risk management and resilience

The session content and format were developed as follows:

<table>
<thead>
<tr>
<th>Topic area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation Dialogue Steering for Risk Management and Resilience</td>
</tr>
</tbody>
</table>

**How does the session contribute to the topic area? (Approx. 200 words)**

The session will examine applied methodologies of NBS towards risk management and resilience in various settings and related risks: i.e. urban, land, coastal ecosystems. The demand for holistic approaches for achieving resilience is high, since the negative impacts of potential risks affect various social, environmental and economic aspects. In this context, there is a need for identifying synergies among NBS leading to risk management and resilience and ways of adjusting them effectively in planning and decision making. The session will steer dialogue on proposed strategies that would combine multiple policies, actions and practices to prevent or confine extended disasters.

<table>
<thead>
<tr>
<th>Name of speaker</th>
<th>Job title</th>
<th>Stakeholder type (as defined in the proposal)</th>
<th>Institution</th>
<th>Climatic Region (as defined in the proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Landscape Architect</td>
<td>Business representatives &amp; Market actors</td>
<td>ARUP</td>
<td>Oceanic</td>
</tr>
<tr>
<td></td>
<td>Non-profit organization management</td>
<td>Policy makers, Scientists &amp; Experts</td>
<td>IUCN</td>
<td>Continental</td>
</tr>
<tr>
<td></td>
<td>Civil engineer</td>
<td>Scientists &amp; Experts, Business representatives &amp; Market actors</td>
<td>Witteveen + Bos Pension Fund, EcoShape, Deltares</td>
<td>Oceanic</td>
</tr>
</tbody>
</table>
Targeted Audience

The targeted audience includes scientists/experts (aware of possible NBS synergies), planners / policy makers and decision makers (end users / authorities).

Format and structure of the session. Briefly describe how the session will unfold (Approx. 200 words)

The session is structured in two parts. In the first part, three short presentations will be provided by experts specialized in planning and/or implementation of combined NBS (overall duration of 30 minutes), inspiring audience for the second part, when an interaction process will take place.

The three presentations will cover different types of application areas, where combinations of NBS can be implemented for achieving risk management and resilience: a) urban settings, b) agricultural land and forests and c) coastal areas. These presentations will introduce attendees to specific NBS practices that can be successfully combined in each application area.

During the second part, a dialogue process will be applied, combining participatory tools (e.g. round table discussions, post-it notes, open questionnaires). The audience will investigate the following issues/questions through two dialogue phases:

1st dialogue phase:

Table 1 (Moderator: , Minute taker: Erik Mink)
- What is the greatest hazard potential in Europe and what are the related existing policies (EU to regional level) and tools for risk mitigation?

Table 2 (Moderator: , Minute taker: Stavros Stagakis)
- Who are the stakeholders involved and what are the decision making mechanisms in defining the strategies for risk management?

Table 3 (Moderator: , Minute taker: Giorgos Somarakis)
- What is the current status of involving NBS (or ecosystem-based strategies) in the EU and regional policy context?

2nd dialogue phase:
Table 1 (Moderator: [Redacted], Minute taker: Erik Mink)

- Which are the most prominent NBS approaches/practices (or combinations of them) for risk management and resilience?

Table 2 (Moderator: [Redacted], Minute taker: Stavros Stagakis)

- What would be alternative decision making mechanisms to facilitate NBS uptake in risk management & resilience?

Table 3 (Moderator: [Redacted], Minute taker: Giorgos Somarakis)

- How to facilitate uptake of NBS in the strategies for risk management and resilience at diverse spatial levels?
  - Identification of Barriers (knowledge, financing, policy)
  - Policy proposals

How do you think the session can help scale-up NbS? (Approx. 200 words)

The issues that will be discussed among participants in this session and the respective conclusions that will be drawn are expected to boost wider application of NBS towards risk management and resilience.

- Knowledge exchange will lead to increased awareness of NBS potentials among participants.
- The issues discussed and the conclusions of this session will be open to wider public discussion in the ThinkNature platform for broader communication.
- The results of this discussion will be analyzed and published in ThinkNature reports and the Handbook.
- The conclusions are expected to contribute to the knowledge regarding NBS for Risk Management and Resilience and form guidelines for adapting NBS in planning and decision-making frameworks.

What are expected deliverables? (Approx. 200 words)

The outcomes of the dialogue process will enrich the content of:
• WP4 and more specifically T4.4 and the corresponding deliverable “D4.4: Report on Dialogue Steering Statement Papers and Dialogue Outcomes for the Risk Management and Resilience”.

• WP5 and particularly T5.4 and the corresponding deliverable “D5.4: Policy proposals and decision making mechanisms for Risk Management and Resilience”.

• WP6 and especially T6.2 and the corresponding deliverable “D6.2: The ThinkNature Handbook”.

Specifically, the participatory approaches applied in this session will target to draw conclusions on the following issues regarding diverse ecosystem types (urban, land and water):

• Risks and identification of them addressed with NBS.

• NBS and combinations of them appropriate for risk management and resilience.

• Policy proposals and decision making mechanisms promoting NBS as an integrated approach in risk management and resilience at both regional and local level.

**Which stakeholders will be able to use the deliverables and in what way? (Approx. 100 words)**

Deliverables can be used by the aggregate of NBS stakeholders. Specifically, the following groups can exploit the produced knowledge in several ways:

• Scientists/experts: Enhancing their knowledge on the technology and practice and incorporating potential combinations of NBS in their research and practice fields.

• Planners/policy makers: Being updated on new case studies and related planning approaches and proposing combined NBS through planning and policy-making processes.

• Decision makers (end users/authorities): Using the information regarding the potential use of NBS for RM&R, the barrier analysis and the proposals for policy and decision making mechanisms.
Business representatives / market actors: Investigating the new business opportunities for using NBS in RM&R and directing market or their business activities to NBS applications.

The session structure in detail follows:

1st part (duration: 30 minutes)
In the first part, three short presentations will be provided by experts specialized in planning and/or implementation of combined NBS (overall duration of 30 minutes), inspiring audience for the second part, when an interaction process will take place.

The three presentations cover different types of application areas, where combinations of NBS can be implemented for achieving risk management and resilience: a) urban settings, b) agricultural land and forests and c) coastal areas. These presentations will introduce attendees to specific NBS practices that can be successfully combined in each application area.

2nd part (duration: 90 minutes)
During the second part, a dialogue process will be applied, combining participatory tools (i.e. focus groups, post-it notes), combining plenary (introduction) and table sessions (dialogue phases and conclusions) (see Table 4, Table 5, Table 6).

Table 4. The 14 steps for implementing the participatory process.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Step</th>
<th>Duration (minutes)</th>
<th>Responsible person (see Table 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1. Explaining the utility of emerged results and rules of the participatory process to all participants</td>
<td>10</td>
<td>Session moderator</td>
</tr>
<tr>
<td></td>
<td>2. Splitting participants into 3 tables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st dialogue phase</td>
<td>3. Asking everyone a warm-up question (e.g. introducing himself/herself)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Asking everyone the pre-decided question (see Table 5)</td>
<td>5</td>
<td>Table moderator</td>
</tr>
<tr>
<td></td>
<td>5. Suggesting participants to think about it, write down their initial thoughts on post-its and attach them on board</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6a. Encouraging all participants to respond and complement their initial responses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phase | Step | Duration (minutes) | Responsible person (see Table 5)
--- | --- | --- | ---
6b. Recording/illustrating participants’ ideas | 20 | Minute taker
7. Suggesting participants to write down their final thoughts on post-its and attach them on board (see Table 6) | 5 | Table moderator
8. Asking everyone the pre-decided question (see Table 5) | 5 | Table moderator
9. Suggesting participants to think about it, write down their initial thoughts on post-its and attach them on board | 5 | Table moderator
10a. Encouraging all participants to respond and complement their initial responses | 20 | Minute taker
10b. Recording/illustrating participants’ ideas | 20 | Minute taker
11. Suggesting participants to write down their final thoughts on post-its and attach them on board (see Table 6) | 5 | Table moderator

Conclusion
12. Summarizing the main points of the discussion | 10 | Minute taker
13. Asking participants about the accuracy of the summary
14. Reminding the utility of emerged results

Table 5. Questions, moderator and minute taker per table.

<table>
<thead>
<tr>
<th>Table</th>
<th>Moderator</th>
<th>Minute taker</th>
<th>1st dialogue phase</th>
<th>2nd dialogue phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Erik Mink</td>
<td>What is the greatest natural hazard potential in Europe and what are the related existing policies (EU to regional level) and tools for risk mitigation?</td>
<td>Which are the most prominent NBS approaches/practices (or combinations of them) for risk management and resilience?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Giorgos Somarakis</td>
<td>Who are the stakeholders involved and what are the decision-making mechanisms in defining the strategies for risk management?</td>
<td>What would be alternative decision-making mechanisms to facilitate NBS uptake in risk management &amp; resilience?</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Stavros Stagakis</td>
<td>What is the current status of involving NBS (or ecosystem-based strategies) in the EU and regional policy context?</td>
<td>How to facilitate uptake of NBS in the strategies for risk management and resilience at diverse spatial levels? Identification of barriers (knowledge, financing, policy, governance)</td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Example of dividing table’s board area for post-its.

<table>
<thead>
<tr>
<th></th>
<th>1st dialogue phase</th>
<th>2nd dialogue phase</th>
</tr>
</thead>
</table>

1 1 minute for initial response and afterwards 0,5 in case of complementing per each participant.
2 1 minute for initial response and afterwards 0,5 in case of complementing per each participant.
2.2.2 NBS for risk management across scales: synergies from local to regional and continental level

The session content and format were developed as follows:

<table>
<thead>
<tr>
<th>Topic area</th>
</tr>
</thead>
<tbody>
<tr>
<td>How to offer synergies in reducing multiple risks in regional level. How the risk management in local levels influences regional and EU level.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How does the session contribute to the topic area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving risk management and resilience using nature-based solutions can lead to greater benefits than conventional methods and offer synergies in reducing multiple risks. The scope of this brainstorming session and debate is to explore apart from the benefits, the possible synergies across different levels/areas and the various barriers to be faced when applying risk management through nature-based solutions.</td>
</tr>
</tbody>
</table>

The implications and interactions of different spatial scales during this process, are another very important aspect that will be examined.

Therefore, the topic of risk management and resilience through NBS is explored taking into account:
a) The interactions of environmental aspects when applying NBS for Risk Management and Resilience with the other pillars of sustainable development (Culture, Economy, Society)

b) The effect of applying NBS for Risk Management and Resilience in different scales and their impact (Local vs Regional and International)

c) The existing governance and legislative barriers that impede the successful implementation and wide replication of NBS for Risk Management and Resilience.

<table>
<thead>
<tr>
<th>Name of speaker</th>
<th>Job title</th>
<th>Stakeholder type</th>
<th>Institution</th>
<th>Climatic Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denia Kolokotsa</td>
<td>Associate Professor</td>
<td>Scientists and Experts</td>
<td>TUC</td>
<td>Mediterranean</td>
</tr>
<tr>
<td>Sara Van Rompaey</td>
<td>Architect</td>
<td>Scientists and Experts/ End Users</td>
<td>E2ARC</td>
<td>Oceanic</td>
</tr>
<tr>
<td></td>
<td>Architect engineer / urban planner</td>
<td>Policy Makers End Users/ Authorities</td>
<td>AGSL, city development agency of the City of Leuven</td>
<td>Oceanic</td>
</tr>
</tbody>
</table>

Targeted Audience

Scientists and Experts familiar with NBS, Authorities, Policy Makers

Format and structure of the session. Briefly describe how the session will unfold
• Each speaker will be assigned to an exercise.
• At the beginning of each exercise the invited speaker will make a brief introduction about the topic addressed (10min).
• The speaker will then address a specific question to the audience. (This question should be defined soon)
• “Storyboarding”: The participants, in groups of max7, will brainstorm on the question and write down their input on moderation cards. Ranking of suggestions: we should aim for a top-10 of ideas/ proposals. (~20 min)
• Necessary to walk around the tables and follow the process
• Remind participants before the end that “now is the time to write things down”
• Poster board on one wall to write the questions and then collect the answers
• Speaker to go through input received by each group of participants and present them.

Suggested sub-topics for the Session:
• Introduction for NBS for risk management across scales (Prof. Denia Kolokotsa- TUC)
• The impact of scale when implementing NBS - cases a.o. Copenhagen Cloudburst Management Plan
• NBS and Cultural Heritage in synergy for risk management: an innovative approach for creating resilient cities (Sara van Rompaey- E2ARC)
• Overcoming governance barriers to promote successful stakeholder synergies

How do you think the session can help scale-up NbS?
During the session, planning strategies for the development, up-scaling and replication of NBS will be proposed and discussed.
Successful case studies that have taken steps to meet their resilience goals expanding Nature’s role will be presented.
A set of recommendations and practical guidelines to better communicate the value of NBS to practitioners will be drafted.
What are expected deliverables? (Approx. 200 words)

The outcomes of the dialogue process will enrich the content of:

- WP5 and particularly T5.4 and the corresponding deliverable “D5.4: Policy proposals and decision-making mechanisms for Risk Management and Resilience”.
- WP6 and especially T6.2 and the corresponding deliverable “D6.2: The ThinkNature Handbook”.

Which stakeholders will be able to use the deliverables and in what way? (Approx. 100 words)

- Scientists/experts: Enhancing their knowledge on the practice of NBS for Risk Management and Resilience.
- Planners /policy makers: Being updated on new case studies and related planning and governance approaches that can possibly be replicated.
- Decision makers (end users / authorities): Using recommendations for policy and decision-making mechanisms.

The detailed session structure follows:

The session was structured in 4 exercises. 4 experts were identified to make short presentations on an assigned topic. To start the discussion, short presentations were provided by each expert, inspiring audience for the second part, when an interaction process took place.

- Each speaker was assigned to an exercise.
- At the beginning of each exercise the invited speaker made a brief introduction about the topic addressed (10min).
- The speaker then addressed a specific question to the audience.
“Storyboarding”: The participants, in groups of max7, brainstormed on the question and wrote down their input on moderation cards. Ranking of suggestions followed (~20 min)

Moderator and panellists walked around the groups and followed the process reminding participants before the end that “now is the time to write things down”

A poster board on a wall was used to write the questions and then collect the answers

The answers were collected each time before the start of the next exercise.

While audience brainstormed on each new question, the expert from the previous exercise went through the input received through the moderation cards, identifying the main ideas to present as conclusions at the end of the session.

The main conclusions from the 4 brainstorming exercises were presented by each respective expert before the closing of the session.

2.2.3 Innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation

The session content and format were developed as follows:

<table>
<thead>
<tr>
<th>Topic area (as defined in the proposal)</th>
<th>Innovation Dialogue Steering for Risk Management and Resilience</th>
</tr>
</thead>
</table>

**How does the session contribute to the topic area? (Approx. 200 words)**

The session explores innovative applications for monitoring and quantifying the effects of NBS towards climate resilience and risk mitigation. Methodologies for measuring the impact of NBS against risks such as heat waves, hydrological floods and landslides will be discussed. The role of different sectors and stakeholders to the development of multi-disciplinary and trans-disciplinary approaches for robust NBS monitoring and impact evaluation will be assessed. The session will also investigate the potential of multiple EU initiatives, infrastructure (e.g. Copernicus services) and Research & Innovation developments to serve as common tools for continuous, long-term and large-scale monitoring of NBS impacts. This session will
seek the methodological, knowledge and technological drawbacks that may prevent the development and the harmonization of NBS monitoring methodologies and explore the possible actions to overcome such barriers.

<table>
<thead>
<tr>
<th>Name of speaker</th>
<th>Job title</th>
<th>Stakeholder type (as defined in the proposal)</th>
<th>Institution</th>
<th>Climatic Region (as defined in the proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nektarios Chrysoulakis</td>
<td>Director of Research</td>
<td>Scientists &amp; Experts</td>
<td>FORTH</td>
<td>Mediterranean</td>
</tr>
<tr>
<td></td>
<td>Business developer</td>
<td>Business representatives &amp; Market actors, Scientists &amp; Experts</td>
<td>VITO</td>
<td>Oceanic</td>
</tr>
<tr>
<td></td>
<td>Researcher</td>
<td>Business representatives &amp; Market actors, Scientists &amp; Experts</td>
<td>Tecnalia</td>
<td>Mediterranean</td>
</tr>
</tbody>
</table>

**Targeted Audience**

The targeted audience includes scientists/experts that are specialized in NBS application, monitoring and assessment.

**Format and structure of the session. Briefly describe how the session will unfold (Approx. 200 words)**

The session is structured in two parts. In the first part, short presentations will be provided by experts specialized in NBS monitoring and impact assessment methodologies (overall duration of 30 minutes), inspiring audience for the second part, when an interaction process will take place.

During the first part, there will be three presentations, regarding different methodologies, tools and indicators meeting diverse monitoring and assessment needs. These presentations will introduce attendees to integrated methodologies
or specific components of them, used for impact and performance evaluation purposes.

During the second part, a dialogue process will be applied, combining participatory tools (e.g. focus groups) and asking audience to investigate the following issues through two dialogue phases (overall duration of 90 minutes):

1st dialogue phase: Investigating gaps and barriers on evaluating NBS contribution in risk management and resilience.

Table 1+2 (Moderator: Nektarios Chrysoulakis/ , Minute taker: Maria Lilli / Katerina Lilli)
- What are the most critical requirements of the methodologies in order to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience?

Table 3 (Moderator: , Minute taker: Juraj Jurik)
- Are there available monitoring methodologies or indicators to evaluate NBS contribution to risk management and resilience? (Explore technological/methodological/knowledge limitations, gaps and drawbacks in the available/applied NBS impact assessment methodologies)

2nd dialogue phase: Recognizing emerging methodologies on NBS monitoring and evaluation

Table 1+2 (Moderator: Nektarios Chrysoulakis/ , Minute taker: Maria Lilli / Katerina Lilli)
- Explore and suggest new tools and infrastructure that meet the recognized critical requirements to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience.

Table 3 (Moderator: , Minute taker: Juraj Jurik)
- Explore and suggest approaches for indicator development, data standardization and methodology harmonization for improving NBS assessment schemes towards risk management and resilience.
How do you think the session can help scale-up NbS? (Approx. 200 words)

The contribution of this session to the escalation of NBS is relevant to the issues that will be discussed among participants, resulting in the implementation of more effective NBS monitoring schemes with regard to the objectives of risk management and resilience and climate change adaptation and mitigation:

- Increase awareness of the NBS impacts and monitoring schemes
- New methodologies and components of them will be discussed and can be opened to wider public discussion in the ThinkNature platform for broader communication
- New technologies that can offer increased effectiveness in the monitoring methodologies
- Contribute to the initiatives for the improvement and wide application of a common NBS Impact Evaluation Framework

What are expected deliverables? (Approx. 200 words)

The outcomes of the dialogue process will enrich the content of:

- WP6 and especially T6.2 and the corresponding deliverable “D6.2: The ThinkNature Handbook”.

Which stakeholders will be able to use the deliverables and in what way? (Approx. 100 words)

Deliverables can be used by the aggregate of NBS stakeholders. Specifically, the following groups can exploit the produced knowledge in several ways:

3. - Planners / policy makers: efficient planning of strategies taking into account NBS impacts and proposing methodologies regarding performance monitoring after the implementation stage of NBS.

4. - Decision makers (end users / authorities): using the results of monitoring and assessment for choosing the appropriate NBS.

5. - Business representatives / market actors: including monitoring and assessment methodologies in market practices and business plans.

The detailed session structure follows:

1st part (duration: 30 minutes)

During the first part, there will be three presentations, regarding different methodologies, tools and indicators meeting diverse monitoring and assessment needs. These presentations will introduce attendees to integrated methodologies or specific components of them, used for impact and performance evaluation purposes.

2nd part (duration: 90 minutes)

During the second part, a dialogue process will be applied, combining participatory tools (i.e. focus groups, post-it notes), combining plenary (introduction) and table sessions (dialogue phases and conclusions). The 14 steps of the participatory process of this session are the same as the first session (Table 4), following the same example of dividing table’s board area for post-its (Table 6). Table 7 presents the responsible persons for each dialogue table and phase.

Table 7. Questions, moderator and minute taker per table.

<table>
<thead>
<tr>
<th>Table</th>
<th>Moderator</th>
<th>Minute taker</th>
<th>Questions</th>
<th>2nd dialogue phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nektarios Chrysoulakis</td>
<td>Maria Lilli</td>
<td>What are the most critical requirements of the methodologies in order to provide efficient and holistic NBS monitoring/evaluation</td>
<td>Explore and suggest new tools and infrastructure that meet the recognized critical requirements to provide efficient and holistic NBS monitoring/evaluation</td>
</tr>
<tr>
<td>2</td>
<td>Katerina Lilli</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Juraj Jurik</td>
<td>Are there available monitoring methodologies or indicators to evaluate NBS contribution to risk management and resilience? (Explore technological/methodological/knowledge limitations, gaps and drawbacks in the available/applied NBS impact assessment methodologies)</td>
<td>Explore and suggest approaches for indicator development, data standardization and methodology harmonization for improving NBS assessment schemes towards risk management and resilience.</td>
<td></td>
</tr>
</tbody>
</table>
2.3 Initiation of Dialogue on the ThinkNature Platform

Except for the Paris Forum dialogue, the ThinkNature platform was used for enriching relevant knowledge regarding the discussion issues of Paris Forum. Specifically, five discussion posts were created in the dialogue section about “Risk Management and Resilience” (Figure 4) in a period of about one and a half month between 23rd of April and 7th of June. These discussion posts are related to specific dialogue sessions of the Paris Forum (Table 8) and contained results of these sessions concisely, intriguing diverse groups of NBS stakeholders to express their views according to their respective knowledge and experience.

Figure 4. Dialogue section of “Risk Management and Resilience“ on the ThinkNature platform.

Table 8. Matching dialogue themes of Paris Forum with discussion posts on ThinkNature Platform.

<table>
<thead>
<tr>
<th>Dialogue Theme of Paris Forum</th>
<th>Discussion Post on ThinkNature Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combining NBS as an integrated approach for risk management and resilience</td>
<td>Paris Forum results on natural hazards and NBS approaches</td>
</tr>
<tr>
<td></td>
<td>Paris Forum results on stakeholders’ involvement and decision-making</td>
</tr>
<tr>
<td></td>
<td>How can we facilitate the uptake of NBS in the EU policy frameworks for risk management and resilience?</td>
</tr>
<tr>
<td>NBS for risk management across scales: synergies from local to regional and continental level</td>
<td>Paris Forum results on &quot;NBS for risk management across scales: synergies from local to city and regional level&quot;</td>
</tr>
<tr>
<td>Innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation</td>
<td>How can the NBS effectiveness in Risk Management and Resilience be monitored and evaluated?</td>
</tr>
</tbody>
</table>
3 State of Dialogue on Risk Management and Resilience

3.1 Dialogue on combining NBS as an integrated approach for risk management and resilience

The dialogue on the topic of combining NBS as an integrated approach for risk management and resilience during the Paris Forum and the ongoing ThinkNature platform threads was separated into six different subtopics (in the form of questions) as described in Section 2.1 and Table 3.

What is the greatest hazard potential in Europe and what are the related existing policies (EU to regional level) and tools for risk mitigation?

Europe is experiencing an increasing number of hydro-meteorological, geophysical and technological disasters that are caused by a combination of changes in its physical, technological and human/social systems. Natural disasters and hazards, triggered by either natural or human factors, have become an issue of growing concern (Poursanidis & Chrysoulakis, 2017). According to the recent annual review by the UNISDR (UNISDR, 2015), 87% of the disasters are driven by the negative effects of climatic change in tandem with the degradation of natural environment.

Approximately 60% of all ecosystem services and up to 70% of regulating services are being degraded or used unsustainably (Millennium Ecosystem Assessment, 2005). This link due to a number of human activities, mainly:

- over-exploitation of resources or higher demand for ecosystem goods than can be sustained, such as overfishing;
- land use and land cover changes, or changes to habitats due to conversion to croplands and urbanization;
- climate change impacts are affecting ecosystems and exacerbating environmental degradation;
- invasive alien species are introduced species that compete and encroach vigorously upon native species, with the potential to degrade ecosystem services and cause severe economic damage;
- pollution, from chemical waste and agricultural inputs, has severely degraded many ecosystem services, and continues to act as a major driver of change.
The main hazards in Europe include floods, storms events (causing flash floods and landslides), drought, heat waves and wildfires (Table 9). The stakeholder dialogues during the Paris forum suggested also different hazards corresponding to the participants’ fields of interest (Figure 8):

1. sea level rise, leading to coastal flooding
2. extreme precipitation events (cloudbursts - storms), leading to fluvial and pluvial flooding
3. more frequent and longer droughts, leading to lack of fresh water (especially in southern Europe)
4. soil degradation, leading to poorer harvests and biodiversity loss (food supply)
5. temperature rise and more frequent heat waves, leading to urban heat stress
6. loss of biodiversity, collapse of ecosystems

The participants noted not only the hazards but also their possible causes and other related unwanted effects. Note that only pluvial flooding and heat stress are hazards that directly involve urban zones. The other hazards affect urban zones only indirectly and need the support of different types of NBS.

Based on the NBS portfolio and the current knowledge of NBS impacts on hazard mitigation (see Section 1.2), the Paris Forum session participants elaborated on specific suggestions of how NBS could address the aforementioned hazards. The focus of risk mitigation is very diverse:

<table>
<thead>
<tr>
<th>Hazard type</th>
<th>Recorded events</th>
<th>Number of fatalities</th>
<th>Overall losses (EUR billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storm</td>
<td>155</td>
<td>729</td>
<td>44.338</td>
</tr>
<tr>
<td>Extreme temperature</td>
<td>101</td>
<td>77 551</td>
<td>9.962</td>
</tr>
<tr>
<td>Forest fires</td>
<td>35</td>
<td>191</td>
<td>6.917</td>
</tr>
<tr>
<td>Drought</td>
<td>8</td>
<td>0</td>
<td>4.940</td>
</tr>
<tr>
<td>Flood</td>
<td>213</td>
<td>1 126</td>
<td>52.173</td>
</tr>
<tr>
<td>Snow avalanche</td>
<td>8</td>
<td>130</td>
<td>0.742</td>
</tr>
<tr>
<td>Landslide</td>
<td>9</td>
<td>212</td>
<td>0.551</td>
</tr>
<tr>
<td>Earthquake</td>
<td>46</td>
<td>18 864</td>
<td>29.205</td>
</tr>
<tr>
<td>Volcano</td>
<td>1</td>
<td>0</td>
<td>0.004</td>
</tr>
<tr>
<td>Oil spills</td>
<td>9</td>
<td>n/a</td>
<td>No comprehensive data available (*)</td>
</tr>
<tr>
<td>Industrial accidents</td>
<td>339</td>
<td>169</td>
<td>No comprehensive data available (*)</td>
</tr>
<tr>
<td>Toxic spills</td>
<td>4</td>
<td>n/a</td>
<td>No comprehensive data available (*)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>928</strong></td>
<td><strong>98 972</strong></td>
<td><strong>148.831</strong></td>
</tr>
</tbody>
</table>
- Coastal flooding: stronger sea defences, consisting typically of hybrid blue-green-grey systems
- Fluvial flooding: ecological river basin management
- Pluvial flooding: increase water absorption capacity of soils in the city
- Drought: sustainable water storage and management schemes; reforestation?
- Heat stress: urban NBS, greening the city
- Soil degradation: re-invent sustainable agriculture practices
- Biodiversity loss: fundamental change in land use practices, limit use of biocides and pesticides

Note also that these tools for risk mitigation imply policy changes at all levels. At the EU level this means new policies for integrated coastal zone management (ICZM) and revised common agricultural policy (CAP); it also means wide implementation of EU policy instruments for flooding in river basins (Flood directive) and biodiversity (biodiversity strategy). Table 10 presents an overview of EU-funded initiatives on adaptation. The table presents 19 different tools, platforms and portals that map impacts, present case studies of adaptation, decision support tools, simulate adaptation options and platforms to share experience.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Different types of tools/portals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping of existing/future impacts/vulnerability</td>
<td>Plan2Adapt, CLIMSAVE, TopDad Data Exploration Tool</td>
</tr>
<tr>
<td>Measures/case studies/literature</td>
<td>ADAM, CLIMATE ADAPT, TopDad Data Exploration Tool, ECONADAPT-Toolbox, ECONADAPT-Library</td>
</tr>
<tr>
<td>Decision-making support tools</td>
<td>MEDIATION, UKCIP Adaptation Wizard, CLIMATE ADAPT, ECONADAPT-Toolbox, RAMSES</td>
</tr>
<tr>
<td>Share experience platform</td>
<td>WeAdapt, CLIMATE ADAPT, Adaptation Learning, Climate Collaborium</td>
</tr>
<tr>
<td>Simulate adaptation options</td>
<td>SIMCLIM</td>
</tr>
</tbody>
</table>

Table 10: EU-funded initiatives on adaptation (Ecologic Institute-ECOADAPT)
Which are the most prominent NBS approaches/practices (or combinations of them) for risk management and resilience?

There is increasing momentum for the use of NBS as part of resilience-building strategies, sustainable adaptation and disaster risk management portfolios. NBS recognize that ecosystems are not isolated but connected through the biodiversity, water, land, air and people that they constitute and support. Hence, sustainable ecosystem management is based on equitable stakeholder involvement in land management decisions, land use trade-offs and long-term goal setting. These are central elements to reducing underlying risk factors for disasters and climate change impacts (Sudmeier-Rieux & Ash, 2009).

Healthy ecosystems both reduce vulnerability to hazards by supporting livelihoods, while acting as physical buffers to reduce the impact of hazard events. Ecosystems contribute to reducing disaster risk in numerous ways, providing multiple benefits and services (Millennium Ecosystem Assessment, 2005), such as:

1) **Regulating services**: ecosystems act as “natural infrastructure” for absorbing energy from physical hazard events (regulating service). The natural infrastructure will only be effective if healthy and adequate in proportion to the energy of a hazard event (i.e. poorly maintained protection forests are unlikely to prevent high magnitude avalanche from occurring). Yet, this also holds true for engineered structures, i.e. seawalls and dykes are not always adequate for withholding large magnitude hazards.

2) **Provisioning services**: ecosystems support livelihoods for reducing vulnerability. This holds true especially in developing countries but European populations are also dependent on natural resources for firewood, clean water, irrigation, well-being.

3) **Supporting services**: ecosystems support soil formation, nutrient cycling, or the basis for agriculture and livelihoods.

4) **Cultural services**: many culturally valuable sites, such as National Parks house important wetlands, mountain forests, coastal vegetation, which may buffer hazard events.
NBS are considered very effective in the prevention and reduction of fluvial and pluvial flooding, coastal flooding, landslides and drought (e.g. Browder et al., 2019). There are numerous case studies around the world, where NBS have been successfully implemented to address such risks. In most cases, large scale (i.e. beyond the urban boundaries) integrated solutions are more effective to holistic risk management and resilience. In several cases, the integration of green and grey systems is considered important for the efficient and successful large-scale implementations. Figure 5 shows the case of an urban planning strategy the incorporated NBS to achieve resilience. NBS in urban areas are recognized as multi-functional essential infrastructure for resilience that improves social interaction and physical/ mental health. The presentation of Tom Armour during the Paris NBS Forum included the aspects of design creativity from strategy to imaginative use of space within the layers of the city. It was stressed that the multiple benefits in the urban environment and especially the quantitative results towards risk mitigation and...
resilience have to be measured and better understood. Stronger links between research/policy/implementation and integrated approaches to delivery - partnership working (de siloing traditional cultures) are needed. This is vital to combine blue/green/grey to achieve sustainable development.

The discussion that followed the presentation indicated that there is considerable room to make cities more climate resistant. Measures should not only target the greening of cities, but also integration of grey and green measures, or even the banning of cars from the city centers, so that the heat stress can be reduced by renewed greening in the centers. New societal approaches could be tried, such as re-introduction of the ‘commons’ in the sense of developing a common responsibility and thus stimulate societal interaction. Another suggestion is to create incentives for shared responsibility by proposing green certificates to finance NBS. Combine ecological resilience with ‘sociological resilience’, Or, for short, integrate ecosystems and social systems.

A large scale NBS project example for achieving coastal resilience was presented in the Paris NBS Forum (Figure 6). A case from Indonesia where a mangrove forest is being recovered in a degraded coastal zone subject to erosion. The sediment which is brought in by the tides is made to settle behind easy-to-construct bamboo and brushwood structures. Once the sediment has created a mudflat the mangroves develop autonomously with little help from humans. The natural approach works well and the methodology is supported by the local population and is adopted by local authorities as a means to protect the coastline.
presented also large-scale projects from around the world, implemented by IUCN (Figure 7). The examples of: i) Burkina Faso where a participatory vulnerability assessment was accomplished with community innovation and multiple benefits for the community, ii) Jordan, Egypt where the objective was to restore and sustainably manage pastoral rangelands for the provision of ecosystem services and protection of biodiversity and catalyze scale up regionally and globally, iii) Senegal, where ecosystems and biodiversity conservation was accomplished through a community-based approach to insure local populations livelihoods as well as disaster and climate change resilience, and iv) Rwanda, where 2 M ha of forest landscape are to be restored by 2020 and provide conceptual framework for the decision-making at the national scale and guidelines to deliver the Rwanda’s Bonn commitment and policy targets were presented.

The session discussion on NBS outside the urban zones indicated that the measures are typically large-scale and more in the domain of infrastructure. The decision-making processes and the stakeholders are different from the urban context. The keyword is again: integrated solutions. Combine grey and green systems, design measures integrating agriculture and biodiversity, apply integrated coastal zone management, practice flood management at river basin scale.
Figure 7. The case of improved ecosystems and biodiversity conservation, local populations livelihoods and disaster and climate change resilience in Senegal by IUCN. (Adapted by the presentation of [presentation title] in the Paris NBS Forum).

Main messages from the Paris Forum session on NBS approaches to enhance risk management and resilience (Figure 8):

- The hazards are diverse and multiple.
- NBS in urban context form only a small sector of the overall risk management required in response to climate change phenomena.
- Resilience of ecosystems can be stimulated by enhancing the biological diversity within the system.
- Integration of grey and green solutions is often necessary for successful and resilient systems.
- Integration of ecological solutions and societal responses is necessary to create ‘urban resilience’.
Who are the stakeholders involved and what are the decision-making mechanisms in defining the strategies for risk management?

During dialogue process, various groups of stakeholders were identified by participants. However, each case involves different groups of stakeholders, depending on the scale (state/regional/local) and the kinds of foreground risks (e.g. flood). Specifically, the following main groups of interdisciplinary stakeholders were noticed by participants (Figure 9):

1. Politicians across scales - from regional to local level (government members, state/regional/local administration, etc.)
2. Public agencies (maintenance department of cities, river basin authorities, etc.)

3. Scientists, researchers and other (technical) experts (e.g. land use, urban or other types of planners)

4. (Local) communities/citizens and residents (indigenous people) living in areas, where NBS are going to be implemented (e.g. farmers and other individuals activated in agriculture)

5. Land owners and developers

6. Non-Governmental Organizations

7. Representatives of relevant associations and organizations (e.g. irrigation associations)

8. Businesses/firms (e.g. water treatment companies, banks and insurance companies)

9. Institutions (e.g. environmental), such as universities

Regarding decision-making, they identified spatial scale and statutory framework (different among countries) as crucial factors. Also, they discerned the following mechanisms, in which both top-down approaches and participatory processes are implemented (Figure 9):

- Law regulation - public policies
- Multi-scale management adapting the proposed measures in each case
- Planning and implementation process
- Risk assessment

What would be alternative decision-making mechanisms to facilitate NBS uptake in risk management & resilience?

Common feature of participants’ perspectives about decision making mechanisms was the transition from top-down to bottom-up decision making and the implementation of participatory processes. Specifically, participants proposed the following mechanisms/methodologies (Figure 9):

- Interactive consultation with stakeholders proposing ideas or answering to authorities:
• Involvement of community/citizens in decision making involving groups of people that are usually out of such processes (children, elderly, impoverished, etc.)

• Local associations assemblies coordinated and financed by local authorities

- Decision support systems
- Group model building and participatory modelling techniques
- Cost-benefit analysis of interventions in ecosystems proving the benefits of NBS, functioning as incentives for decision makers
- Results-based mechanisms including outputs and lessons learned from similar case studies
- Assessment techniques considering environmental aspects (e.g. long-range ecosystems services) during planning, implementation and impacts monitoring stages

Furthermore, participants recognized the following crucial issues that should be taken into consideration (Figure 9):

- Informing and engaging all relevant stakeholders
- Convincing decision makers about the impotence of nature and usefulness of NBS
- Persuading public to participate in decision making processes
- Institutionalizing regulations regarding decision making (mechanisms)
- Including sustainability in objectives of decision making, respecting and serving next generations
- Ensuring horizontal (among different sectors and areas) and vertical (between local and regional) interconnection and balance, overcoming the “silos” of information and decision making
Figure 9. Photos from the session on combining NBS as an integrated approach for risk management and resilience of the Paris Forum on NBS and specifically the working group of the second pair of questions (Table 5).
What is the current status of involving NBS (or ecosystem-based strategies) in the EU and regional policy context?

Policy framework and decision-making procedures are of the most crucial factors for the effectiveness of NBS planning and implementation. NBS initiatives aligned with and/or helping support the implementation of policy directives or goals have more chances to be implemented (WBCSD, 2017). Science-based organizations such as the Nature Conservancy (TNC) and the International Union for Conservation of Nature (IUCN), have been active in integrating NBS into policy negotiations (IUCN, 2012).

Ecosystem-based initiatives have been pursued under different policy domains such as adaptation to climate change (EC, 2009; 2013a), biodiversity protection (EC, 2011a), integrated water resource management (EC, 2012; 2014), and disaster risk reduction (EC, 2011b). To ensure the successful deployment of NBS and their integration in existing national policy frameworks, the EC is aligning the R&I agenda on NBS with several EU policies and actions (EC, 2016).

Table 11. EU Directives on Hazards and Risks

<table>
<thead>
<tr>
<th>Relevant EU Directives on Hazards and Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Framework Directive for community action in the field of water policy, 2000/60/EC</td>
</tr>
<tr>
<td>Flood Risk Directive for the assessment and management of flood risks, 2007/60/EC</td>
</tr>
<tr>
<td>EU Civil Protection Mechanism</td>
</tr>
<tr>
<td>Directive on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, 2008/114/EC</td>
</tr>
<tr>
<td>Directive on the Control of major accident hazards involving dangerous substances, 96/82/EC</td>
</tr>
<tr>
<td>Marine Strategy Framework Directive establishes European Marine Regions on the basis of geographical and environmental criteria</td>
</tr>
<tr>
<td>Directive on Strategic Environmental Assessments 2001/42/EC</td>
</tr>
</tbody>
</table>

The following initiatives are identified as prominent to integrate NBS:

- **The Urban Water Agenda 2030** and the **Blueprint to safeguard Europe’s water resources** (EC, 2014) highlight the role of Natural Water Retention and strengthen the implementation of European Union water policies by fostering sustainable urban water management water in cities.
- The **Green Infrastructure Strategy** (EC, 2013b), which promotes the deployment of green infrastructure in urban and rural areas across Europe as well as the development of a Trans-European Network for Green Infrastructure in Europe. It can provide less expensive and long-lasting solutions, as well as deliver health-related and ecological benefits.

- The **EU action plan for disaster-risk reduction** (EC, 2016), linked to the implementation of the EU Action Plan for the Sendai Framework for Disaster Risk Reduction.

- The action plan prepared by **Urban Agenda for the EU Climate Adaptation Partnership (2018)** aimed to provide concrete proposals for the design of future and the revision of existing EU legislation, instruments and initiatives relating to the adaptation to climate change in urban areas in the EU.

The Paris Forum dialogue (Figure 10) pointed out that the current policy frameworks and directives do not integrate NBS (e.g. Table 11). Some strategies (e.g. flood, water management) integrate some ecosystem-based strategies, however, the term green infrastructure is mostly used instead of NBS. There are some shining examples, such as local or regional strategies developed by some countries (e.g. Germany, Sweden, Spain) and cities, which have included and showcased the multiple applications and benefits of NBS. These frontrunners in local level have developed innovative integrated plans involving NBS to address multiple challenges.

The main reason of the limited integration of NBS into the regional policy contexts is that NBS are still in the evidence phase and not the policy phase. Another reason is that an exact definition of NBS is not yet consolidated among the scientific community. Even though, NBS term has already been used for several years and there is already a significant amount of work and literature produced on NBS, the term is not yet widely known among different communities and especially among policy makers. Moreover, participants noted that the targets are still not clear inside the framework of NBS and there is no specific vision towards such targets, so this is also a reason that they are not integrated into the relevant policy contexts.

**How to facilitate uptake of NBS in the strategies for risk management and resilience at diverse spatial levels?**

Participants of the Paris Forum brainstormed on possible drivers that would make NBS more widely used and eventually integrated in the policy contexts related to risk management and resilience (Figure 10). It was agreed that more demonstration
projects are needed to transform NBS from a theoretical concept to an effective practice. A common vision on NBS is needed in order to push and persuade the policy makers. Also, the frontrunner cities and countries should be used as case studies to advance the knowledge on both good and bad practices. The participants worked more closely on the barriers and formulated clear suggestions on facilitating NBS integration into policies for risk management and resilience.

**Identification of barriers (knowledge, financing, policy, governance)**

- The financial aspects related to NBS implementation are still not clear and there are no complete business models.
- Finance of NBS is prerequisite for its transition to governance.
- The already defined policy context regarding the risk management practices can sometimes block the involvement of NBS due to legal requirements.
- There are no legally binding targets among the EU policies related to NBS objectives.
- The private sector is not yet convinced regarding NBS efficiency.
- Knowledge related to NBS implementation (planning, technology, practices) is not yet widely spread among the different communities (science, policy, practitioners).
- Concrete knowledge and evidence of NBS effectiveness in risk mitigation and management is not yet developed.
- The transferability of NBS, as well as their effectiveness across scales, continents, climate zones can be variable.
- Holistic practices (e.g. hybrid green-grey solutions) and their multiscale benefits are not widely implemented or evaluated.
- NBS multifunctionality and multiscale effects pose challenges to define and monitor their effectiveness.
- In contrast to grey solutions, NBS evolve after implementation and in many cases need a number of years to achieve the maximum effectiveness and benefits towards risk management and resilience.
- Political will is needed for making the transition from grey to green.
- Knowledge on synergies and trade-offs between different objectives is not yet developed.
**Policy proposals**

- A first step towards the integration of NBS in policy contexts is the development of a wide consensus on NBS definition, the formulation of NBS standards and implementation guidance.

- Involve specific requirements and criteria that integrate society-economy-environment in order to use EU funds for implementing climate change adaptation/mitigation, risk management and resilience actions at regional and local level.

- Define stricter and legally binding targets for Risk Management & Resilience at EU level.

- Targeted funding tools for NBS implementation at local and EU level are needed.

- Integrate NBS in decision making from local to EU level.

- Better coordination and integration of NBS projects at EU level.

- Promote national/local scale planning and strategies that integrate NBS towards risk management and resilience.

- Perform ex-post assessment on implemented NBS regarding their contribution to the sustainability and resilience.

- The knowledge base on NBS effectiveness should be advanced with more demonstration projects (i.e. inclusion of NBS in Horizon Europe).

- Follow the frontrunner examples of NBS implementation in local and regional level and develop knowledge on good and bad practices.

- Combined and integrative socioeconomic and environmental strategies at local level can be achieved through NBS.

- Policy and strategies for risk management and resilience should take into account projections and scenarios of future challenges and not be based exclusively on today’s problems and needs.

- Multiple stakeholder groups must be involved in the finance and governance aspects of NBS.
• Integrate NBS into multiple key policy areas (e.g. infrastructure, spatial planning, economy).

Figure 10. Photos from the session on combining NBS as an integrated approach for risk management and resilience of the Paris Forum on NBS and specifically the working group of the last two questions (Table 5).
3.2 Dialogue on NBS for risk management across scales: synergies from local to city and regional level

The dialogue on the topic of risk management across scales: synergies from local to city and regional level during the Paris Forum (Figure 14) and the ongoing ThinkNature platform threads was separated into three different subtopics and relevant questions, as described in Section 2.1 and Table 3.

Nature Based Solutions for Climate Change Mitigation & Risk Management across Scales

The concept: NBS allow us to work on different scales, through different approaches and techniques: From Building scale, to Local scale and then to Regional Scale. NBS in buildings are rather straightforward, with an impact mostly on building scale. For local and regional scales, the addressed challenges are more complicated, but there are various solutions that can be implemented.

Main ideas:

NBS definition: NBS are living solutions inspired and supported by nature that simultaneously provide environmental, social and economic benefits and help to build resilience. Nature Based Solutions bring more nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.

- NBS offer solutions for climate related risks e.g.: Heat island effect, extreme cold, river floods, surface water floods, coastal floods, water scarcity/droughts, water quality, fire risks, landslides, storms.

Examples of Green Infrastructure Benefits

<table>
<thead>
<tr>
<th>Green Infrastructure Benefits</th>
<th>Economic Benefits</th>
<th>Social and Environmental Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplace Productivity</td>
<td>Workplace Productivity</td>
<td>Mental Health</td>
</tr>
<tr>
<td>Faster Property Sales</td>
<td>Faster Property Sales</td>
<td>Physical Health</td>
</tr>
<tr>
<td>Property Prices</td>
<td>Property Prices</td>
<td>Wellbeing</td>
</tr>
<tr>
<td>Land Value</td>
<td>Land Value</td>
<td>Childhood Development</td>
</tr>
<tr>
<td>Faster Planning Permission</td>
<td>Faster Planning Permission</td>
<td>Hospital Recovery Rate</td>
</tr>
<tr>
<td>Reduced Energy Cost</td>
<td>Reduced Energy Cost</td>
<td>Tourist and Recreational Facilities</td>
</tr>
</tbody>
</table>
### Examples of what we can do at different scales:

<table>
<thead>
<tr>
<th>NBS - Scales</th>
<th>Building Scale</th>
<th>Local Scale</th>
<th>Regional Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Scale</td>
<td>Green roofs</td>
<td>Bioswales</td>
<td>Urban Forest Management and Maintenance</td>
</tr>
<tr>
<td></td>
<td>Green walls</td>
<td>Bioswales - Raingardens</td>
<td>Peri-Urban Park</td>
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<tr>
<td></td>
<td>Gardens</td>
<td>Tree-lined Streets</td>
<td>Green Noise Barriers</td>
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<tr>
<td></td>
<td>Community Gardens - Urban Farms</td>
<td>Green Bus Shelters</td>
<td></td>
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<tr>
<td></td>
<td>Ditches</td>
<td>Green Living Room</td>
<td>Green Ventilation Grids</td>
</tr>
<tr>
<td></td>
<td>Infiltration Strips and Meadows</td>
<td>Green Corridors</td>
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<tr>
<td></td>
<td></td>
<td>Porous Paving</td>
<td>Sustainable Urban Drainage Systems</td>
</tr>
</tbody>
</table>

- NBS allows us to work on different scales, through different approaches and techniques. From Building scale, to Local scale and then to Regional Scale.

<table>
<thead>
<tr>
<th>Challenges addressed</th>
<th>NBS in buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHI &amp; Surface Water Floods</td>
<td>Green Roofs</td>
</tr>
<tr>
<td></td>
<td>Moss Roofs</td>
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<tr>
<td></td>
<td>Rooftop gardens</td>
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<tr>
<td></td>
<td>Green Facades</td>
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<td></td>
<td>Vertical Gardens</td>
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</tbody>
</table>
Figure 11. The multiple benefits of green infrastructure (adapted from the presentations of Denia Kolokotsa in Paris NBS Forum (Arup, 2014).

<table>
<thead>
<tr>
<th>Challenges addressed</th>
<th>NBS in local scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHI &amp; Surface Water Floods</td>
<td>Rain Gardens</td>
</tr>
<tr>
<td></td>
<td>Green Urban Furniture</td>
</tr>
<tr>
<td></td>
<td>Green Lines</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Challenges addressed</th>
<th>NBS in local/ regional scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHI</td>
<td>Lake Restoration</td>
</tr>
<tr>
<td>Surface Water Floods</td>
<td>River restoration</td>
</tr>
<tr>
<td>River Floods</td>
<td>Dunes construction</td>
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<tr>
<td>Water Scarcity</td>
<td>Coastal wetlands restoration</td>
</tr>
<tr>
<td>Water quality</td>
<td>Urban Forests</td>
</tr>
<tr>
<td>Coastal Floods</td>
<td>Peri Urban Parks</td>
</tr>
<tr>
<td>Fire risks</td>
<td>Land slides</td>
</tr>
</tbody>
</table>

On the one hand we have the different scales. On the other hand, we have decision making: How can we prioritise before and after disasters?

Brainstorming outcomes:

- NBS allows us to work on different scales, through different approaches and techniques. From Building scale, to Local scale and then to Regional Scale.
NBS in buildings are rather straightforward, with an impact mostly on building scale. For local and regional scales, the challenges to face are more complicated, but there are various solutions that can be implemented.

- Risks and potential impacts across all scales have to be evaluated at all times;
- Disaster management should be integrated in every phase of planning;
- There are different levels of scientific knowledge regarding environmental threats at different scales, therefore integration of knowledge between scales is needed;
- Prioritizing depends on future scenarios, institutional/cultural context and governance models at stake;
- There is a discrepancy as to the fact that challenges can be local but solutions regional (and vice versa);
- Vulnerability maps and scales before and after disasters are needed;
- Top down approach should be followed in the implementation phase;
- Disasters can be seen as opportunities to take action making things right

The impact of scale to implementing NBS: From city block, to masterplan and city guidelines

The concept: The impact of scale when implementing NBS and the role of city guidelines, through highlighted case studies. The role of urban infrastructure and its contribution to urban regeneration.

Main ideas: Presentation of 4 case studies that demonstrate the impact of scale when implementing NBS (Figure 12):

1. Zollhallen Plaza in Freiburg, Germany (5600m2) (Ramboll Studio Dreiseitl),
2. Scharnhauser Park, Germany (Ramboll Studio Dreiseitl),
3. Agropark Bernex-Confignon, Switzerland (VWA Architectes)
4. Copenhagen Cloudburst Masterplan, Denmark (Ramboll Studio Dreiseitl)
How can urban infrastructure become regenerative over time, taking into consideration scale?

Brainstorming outcomes:
• Urban infrastructure and multifunctional public spaces to promote health and wellbeing
• Policies needed for implementing strategies
• Flexibility and incremental changes needed
• We have to consider cities as living organisms acting on fluxes;
• Regeneration can also mean replication/ transfer to other cities;
• We need to identify which habits/ behaviours must change. Infrastructures have to facilitate new habits and behaviours;
• Adequate balance needed between physical environment (NBS) and people (users);
• Regenerative Urban Infrastructure can be achieved through: a) economy (real estate) b) ecology c) governance (enable self-maintenance by citizens) d) multifunctionality;
• Infrastructure should be easily adaptable to scenarios and easily replicated;
• We should empower citizens in order to support their sense of ownership;
• Flexibility of solutions enables adaptability;

**NBS and Cultural Heritage in synergy for risk management: an innovative approach for creating resilient cities**

The concept: It is important to promote synergies between Cultural Heritage and NBS for creating resilient cities (Figure 13). State of the art of NBS in synergy with Cultural Heritage

Which are the foundations for creating resilience and which can be new approaches for future proof city planning?

Brainstorming outcomes:

• Better education and training
• Citizen’s Participation- social dimension
• Learning from the past to design for the future
• Focus on service provision rather than infrastructure development;
• Learn from the past, design for the future;
• Future proof city planning --> Flexibility, Demographic change, Participatory planning;
• Interdisciplinary cooperation between experts of different fields;
• Vision and leadership in governance needed;
• Citizen education and Training from early school years;
• Maintain the memory of how NBS changed the livelihood in a given area. For newcomers to understand the history and take ownership;
• Social simulation of resilience models (e.g ABM or AI);
• Increase people’s confidence in data

Figure 13. Opening up of tubed-in river Dyle Leuven (Belgium), an example of NBS & Cultural Heritage in synergy for Risk Management and Resilience (adapted from the presentation of Sara van Rompaey in Paris NBS Forum).

Overcoming governance barriers to promote successful stakeholder synergies

The concept: Governance barriers can be overcome through appropriate strategies and effective stakeholder synergies can be promoted for successful NBS. The example of Leuven Hertogensite NBS project with an overview of the strategies used to overcome governance barriers and to promote effective stakeholder synergies for successful NBS.

How to keep actors and stakeholders engaged and ambitious through the entire process of a complex spatial project

Brainstorming outcomes:
• In an urban regeneration project, it is important to keep the same team from the beginning to the end

• Be clear from the beginning regarding your objectives. “Good friends make good agreements” but also “Good agreements make good friends”

• Develop a business case and consider opening opportunities for private stakeholders;

• Work with communities in a social participation approach;

• Show tangible and visualised results to citizens;

• Build trust towards experts and designers;

• Be clear about the priorities, the process, the stepping stones and the benefits;

• Map stakeholders and influencers;

• Think of incremental development as a way of generating consensus;

• Leverage the points of motivation/ drivers of different actors;

• Communication and simplification are essential
Figure 14. Photos from the session of NBS for risk management across scales: synergies from local to city and regional level of the Paris Forum on NBS.
3.3 Dialogue on innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation

The dialogue on the topic of innovative methodologies for monitoring the efficiency of NBS towards climate resilience and disaster risk mitigation during the Paris Forum and the ongoing ThinkNature platform threads was separated into four different subtopics (in the form of questions), as described in Section 2.1 and Table 3.

What are the most critical requirements of the methodologies in order to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience?

Targeting the wide acceptance and implementation of NBS over grey solutions, it is urgent to showcase the effectiveness of NBS in numbers. This requires the selection and design of robust monitoring methodologies of high scientific quality and accuracy that are capable to quantify the multi-scale NBS impacts. Such methodologies are needed for the establishment and the wide acceptance of a holistic framework for the assessment of NBS impacts across a range of societal challenges and at different geographic scales.

The selection of the appropriate monitoring methodologies for each NBS case depends on various factors, including the objective of the action, the NBS type, the scale of implementation, the expected impacts and co-benefits and the available resources. However, there are some critical methodology requirements that apply for most NBS cases and are needed for the design of an integrated assessment of NBS effectiveness.

The participants of the respective session of the Paris Forum discussed on the status of the methodologies to monitor and evaluate NBS towards achieving efficient Risk Management and Resilience. It was evident in the discussion that there are still many gaps and barriers for achieving a complete framework for monitoring and evaluating NBS. A main challenge to achieve a comprehensive NBS impact evaluation framework is that NBS target multiple and multi-scale benefits, so the monitoring approaches should cover a great number of criteria. The basic requirements for efficient motoring methodologies that came out of this discussion are the following:

- **Long-term and multi-scale capabilities**
The scale of NBS implementation and the scale of the NBS impacts in both space and time must be adequately addressed by the monitoring methodologies. NBS impacts vary from micro (e.g. street level), to meso (e.g. city level) and macro scales (regional to national level). Moreover, NBS are based on dynamic ecosystem processes that evolve during time. NBS impacts would change over time in most cases through unpredictable functions and factors (e.g. changing climate). In some cases, the NBS may unfold its full benefits over a long period of time. Therefore, monitoring methodologies should have the capacity to capture the variable multi-scale effects of NBS in order to provide insights into the functioning of NBS.

- **Availability of baseline data**

NBS performance is ideally evaluated by comparing the status prior and after the implementation. Baseline data represent the pre-NBS situation and their existence in an adequate format, quality and quantity is important for the comparability with post-NBS situation. In some cases, it is not enough if the monitoring starts with the planning and implementation phase of the project. Longer past time-series of data are sometimes needed for the complete evaluation of some environmental effects (e.g. urban temperature reduction). NBS monitoring methodologies must take into account that comparable and accurate baseline datasets should be already available or generated.

- **Quality and accuracy**

The methodologies used must be of the highest scientific quality, taking into account the whole range of physical processes and interactions associated with the monitored parameters. The approaches should be widely accepted by the scientific community and approved by the experts of the related fields. Moreover, the data and methods should have been already validated and ideally should always report the accuracy of the output measures.

- **Data standardization, comparability, replicability**

Monitoring methodologies should generate qualitative and quantitative results that would be comparable across case studies, geographical and temporal scales. Therefore, the data used should be possible to be standardized and replicated under different areas, conditions and scales.
Methodology harmonization

Towards the comparability of the NBS effectiveness measures across scales and geographical areas, the selected methodologies should provide a high potential of harmonization between the different case studies.

Feasibility

Across scientific literature there are several methodologies that use measurements or approaches that are difficult, time-consuming and expensive, the data used are scarce or need extremely specialized equipment to undertake. Such methodologies would be difficult to replicate. Therefore, the ideal monitoring methodologies are the ones that would need the minimum specialized equipment and effort, so that would be feasible to implement across case studies.

Operationalization
The methodologies should have passed the experimental and development phases and reached operationalization. This is prerequisite for the mainstreaming of the monitoring approaches. If not already, they must have the potential to become operational in the future.

Figure 16. Indicators derived by Earth Observation data that can be used to monitor NBS in extended spatial and temporal scales (adapted by the presentation of Nektarios Chrysoulakis in Paris NBS Forum).

- **Multi-criteria approaches**

  Methods based on multi-criteria assessment are often useful for aggregating different types of indicators in order to assess alternative solutions. Such approaches usually adopt multiple different monitoring methodologies and combine their results to derive solutions for the decision makers. Such strategies can also support the consideration of different scales and measures. Toward this effort, participatory decision support tools and processes contribute to more transparent processes for deliberation and decision-making.

- **Multi-disciplinary framework**

  NBS seek to address in the same time economic, environmental and social challenges. It is difficult to recognize the multiple interactions, synergies and trade-
offs within and across NBS projects in respect of the different types of impacts. While having a direct effect on a specific challenge, a NBS may have indirect effects on other aspects of the same or different challenges. Even though NBS have in most cases positive environmental impacts, the social or economic impacts can be ambiguous. Close collaboration of different scientific areas in multi-disciplinary approaches is necessary in most cases to provide a holistic assessment on NBS performance.

- **Cost effectiveness**

A critical parameter for the adoption of specific monitoring methodologies on NBS implementation is the cost associated to the implementation of the monitoring techniques. There is a need to develop simple and cost-effective solutions for the efficient monitoring of NBS considering in the same time all the above criteria.

The above requirements are difficult to fulfil and there are still several gaps towards the design of efficient and holistic methodologies and indicator development. Furthermore, the discussion stressed also the difficulties of the economic valuation of NBS as well as defining the social benefits of NBS. Benefits such as social justice, health or well-being are not easily defined or measured. Inclusion of social perception through citizens observatories or surveys can be favorable to achieve monitoring of social benefits. Participatory approaches and increased stakeholder involvement were also suggested as means to achieve multi-benefit assessment.

Some final thoughts towards the efficient and holistic monitoring of NBS were that the future methodologies should:

- Integrate the temporal dimension (NBS evolution)
- Provide the capacity to integrate collective & local knowledge
- Address and integrate multiple criteria and different disciplines
- Involve multiple stakeholders and the community

**Are there available monitoring methodologies or indicators to evaluate NBS contribution to risk management and resilience?**

Under this subtopic, the participants explored the gaps, challenges and potentials of the monitoring methodologies and indicators to evaluate NBS effectiveness in Risk Management and Resilience. The following gaps and challenges were recognized:

- Lack of harmonization of monitoring variables, methods, assessment tools
o Need for low cost monitoring: There is a need for high quality but at the same time low-cost monitoring not only for data gathering (i.e. sensors, devices), but also for data processing and analysis. Nowadays the available low-cost monitoring techniques do not provide enough quality data/results.

o Poor scientific quality of models: Most of the models being used for climate related parameters are barely validated and some of them- (particularly the easiest to use) can be of poor scientific quality.

o NBS not well represented in the available tools. Therefore, it is difficult to determine and isolate the impact that NBS might have.

o Lack of accurate and accessible baseline data at local level mainly but not only, with regards to biodiversity and pollinators.

o Highly resource consuming online tools e.g. for water quality and flood risk do already exist at local level (i.e. Tampere Municipality). These tools provide data and information not very accurate but have been used also for social awareness and educational purposes. However, the implementation and maintenance costs of such tools are too high.

o Need for differentiation between quality and quantity.

Some more specific outcomes of the knowledge gaps relating to the monitoring methodologies of NBS are the following:

o Restrictions of the monitoring methodologies to link NBS impacts across spatial scales (micro to regional)

o Continuous and long-term monitoring methods are not yet applied in measuring the temporal evolution of the NBS impacts

o Limited knowledge and applications of interdisciplinary methods and research designs to monitor synergies and trade-offs within and across challenges

o The comparability between case study impact monitoring approaches is still limited

o Poor availability of consistent datasets to measure NBS impacts

o The accuracy and quality of the monitoring approaches is still under investigation
Explore and suggest new tools and infrastructure that meet the recognized critical requirements to provide efficient and holistic NBS monitoring/evaluation towards risk management and resilience

Modelling approaches are the most favored towards the integrated NBS evaluation since they offer capacities for building and evaluating the effects of different scenarios and future climate and threat projections (Figure 17). They also support decision support systems, where multiple criteria can be evaluated and offer the best solutions according to the defined goals. Machine Learning was also referred as an advanced modelling approach that provides enhanced capabilities for the model complexity, sophistication and the amount of input data used. However, it was highlighted in the discussion that modelling is not enough for impact evaluation, the monitoring of the actual impacts must be also measured with state-of-the-art methodologies.
Earth Observation (EO) technologies are favorable for the long-term and multiscale measurement of actual NBS impacts (Figure 15, Figure 16). EO has also the valuable advantage for looking back in time and evaluate past implementations or the capacities of habitats to recover after disturbance. Copernicus EO Programme offers solid databases of important *in-situ* and EO-based measurements, along with modeled parameter estimation, providing a unique potential for data harmonization and standardization. The data provided are freely and openly accessible to its users. Cloud-based platforms such as DIAS, ESA TEPs and Google Earth Engine facilitate and standardize access to data and offer advanced processing tools.
Citizen science is also an advancing field that provides encouraging results for new types of analyses and data gathering techniques (Figure 18). There is huge potential for data gathering via citizens observatories although it requires a strong effort for boosting participation. Infrastructure that would exploit citizen science data would be a future favorable advancement for monitoring and evaluating the social impacts of NBS.

The technology of the in-situ measurements and networks has also advanced in the recent years, updating the observational capacity of multiple processes. The smart and low-cost sensor network technologies have been developed under mainly the framework of Wireless Sensor Networks (WSNs). WSNs are today widely applied in monitoring physical or environmental conditions with multiple applications in urban areas (e.g. air pollution, traffic, meteorology, noise), natural environment (e.g. water quality, animal tracking), risk management (e.g. landslides, forest fires, flooding, earthquakes), industry (e.g. waste monitoring, machine conditions), health (e.g. physical state tracking, health diagnosis).

Several other initiatives, networks, models and platforms were referred during the dialogue since they are promoting knowledge regarding NBS impacts, such as:

- EcoActuary (http://www.policysupport.org/ecoactuary)
- CostingNature (http://www.policysupport.org/costingnature)
- Climate KIC tool (https://www.climate-kic.org/projects/adaptation-tool-for-local-authorities-atla/)
- Natural Capital Planning Tool (http://ncptool.com/)
- EcoAdapt (http://www.ecoadapt.org/)
- Oasis Platform (https://www.climatefinancelab.org/project/climate-risk-assessment/)
- ThinkNature platform (https://platform.think-nature.eu/)

In conclusion, the participants stressed the need to develop NBS guidelines and a global standard that would foster legislation changes and influence European and National Policy centers. Training of experts according to these standards and subsequent tools would also promote NBS implementation and advance monitoring technologies.
Explore and suggest approaches for indicator development, data standardization and methodology harmonization for improving NBS assessment schemes towards risk management and resilience

Opportunities for future developments in the NBS monitoring methodologies:

- Monitoring framework: a short list of evaluation topics and potential KPIs is needed to assess NBS effectiveness to support decision making considering long-term implementation and maintenance, bespoke to different bio-regions. This is very much the aim of the EC Task Force II on NBS Impact Assessment.

- NBS contribution to policy objectives (e.g. SDGs) should be connected to the monitoring framework.

- Building capacity: Different levels of knowledge/expertise needed depending on the risk and NBS: ecosystem services assessment and health are identified as integrated approaches to assess NBS effectiveness.

- Citizens’ observatories- not that accurate though but still very powerful to provide information on social perception and evaluation of emotional experiences as well as for empowering society and increase sense of co-responsibility and identity.

- Comparative assessment between NBS and grey solutions to build confidence and towards legitimacy.

- Validation of models and low-cost monitoring towards good quality data and results.

- Mainstreaming NBS into policy: comprehensive consideration of NBS into existing policy framework i.e. integrated policies such as spatial planning and land use, but also sector policies such as agriculture, health, energy, water, soil, etc.

- Standardization for design/delivery/monitoring:

  - global standard of quality NBS to be used by engineers/developers/practitioners, when delivering NBS projects. IUCN has launched already this process.

  - monitoring KPIs for evaluation of NBS effectiveness.
From the EU perspective there is a need for:

- more/better exploitation of “Copernicus” - An effort is required for downscaling the data/resources offered by Copernicus at local level.
- increase alignment with EU Directives: i.e. Water Framework Directive, Biodiversity,
- harmonization of reporting with regards to disaster risk reduction to allow comparability.

Considering that climate change is a global challenge, a global diagnosis is also required, going beyond the EU resources and data - again harmonization is needed.
4. Conclusions

The dialogue outcomes for the Risk Management and Resilience prove that NBS is a rapidly growing concept with a great potential when integrated in risk management strategies. However, neither NBS concept nor the policy and decision-making framework around Europe has reached the maturity to scale up and mainstream NBS implantation towards resilience goals. There is still a lot of work to be done to reach this stage. The main messages of the dialogue are the following:

- A wide consensus on NBS definition and the formulation of global NBS standards are important conditions for mainstreaming NBS in the strategies for risk management and resilience.

- Transition from top-down to bottom-up decision making and the implementation of participatory processes are needed for the facilitation of NBS uptake.

- Large scale (i.e. beyond the urban boundaries) integrated solutions that combine green and grey systems and rely on biodiversity are the key concepts for holistic risk management and resilience.

- Vulnerability mapping should be among the top priorities in order to define the strategies for risk management and resilience.

- Holistic NBS monitoring and impact evaluation is important to provide quantitative proof of NBS benefits for risk management and resilience,

- NBS monitoring is challenging due to the multiple (environmental, social, economic) and multi-scale (temporal - spatial) NBS benefits that are not yet clearly defined or fully recognized.
• Technological advances in modelling capabilities, Earth Observation data and citizen science are very promising and can be used as tools for achieving a complete NBS monitoring and evaluation framework.

• In parallel to the maturity of the NBS impact assessment and the policy and decision-making framework, maturity of the society is also needed in order to implement NBS instead of grey solutions.

Regarding mainstreaming NBS as concrete strategy for Risk Management and Resilience, several barriers have been identified:

• The financial aspects related to NBS implementation are still not clear and there are no complete business models.

• Finance of NBS is prerequisite for its transition to governance.

• The already defined policy context regarding the risk management practices can sometimes block the involvement of NBS due to legal requirements.

• There are no legally binding targets among the EU policies related to NBS objectives.

• Private sector is not yet convinced regarding NBS efficiency.

• Knowledge related to NBS implementation (planning, technology, practices) is not yet widely spread among the different communities (science, policy, practitioners).

• Concrete knowledge and evidence of NBS effectiveness in risk mitigation and management is not yet developed.

• The transferability of NBS, as well as their effectiveness across scales, continents, climate zones can be variable.

• Holistic practices (e.g. hybrid green-grey solutions) and their multiscale benefits are not widely implemented or evaluated.

• NBS multifunctionality and multiscale effects pose challenges to define and monitor their effectiveness.

• In contrast to grey solutions, NBS evolve after implementation and in many cases need a number of years to achieve the maximum effectiveness and benefits towards risk management and resilience.
• Political will is needed for making the transition from grey to green.
• There is a difficulty integrating various skills.
• Knowledge on synergies and trade-offs between different NBS objectives is not yet developed.

Regarding the methodologies for monitoring and evaluation NBS effectiveness, the following knowledge gaps and methodological barriers have been identified:

• Restrictions of the monitoring methodologies to link NBS impacts across spatial scales (micro to regional).
• Continuous and long-term monitoring methods are not yet applied in measuring the temporal evolution of the NBS impacts.
• Limited knowledge and applications of interdisciplinary methods and research designs to monitor synergies and trade-offs within and across challenges.
• The comparability between case study impact monitoring approaches is still limited.
• Poor availability of consistent datasets to measure NBS impacts.
• The accuracy and quality of the monitoring approaches is still under investigation.
• Lack of harmonization and standardization of monitoring variables, methods, assessment tools
• Tradeoffs between cost effectiveness and data quality
• Poor scientific quality of models
• Lack of baseline data at local level
• Highly resource consuming online tools
• Economic valuation of NBS
• Social benefit definition and measurement can be subjective

The dialogue revealed specific **recommendations** for policy makers and scientists to help NBS integration into the strategies for Risk Management and Resilience:
• Involve specific requirements and criteria on EU funds that integrate societal-economical-environmental benefits for implementing climate change adaptation/mitigation, risk management and resilience actions at regional and local level.
• Define stricter and legally binding targets for Risk Management & Resilience at EU level.
• Targeted funding tools for NBS implementation at local and EU level.
• Integrate NBS in decision making from local to EU level.
• Better coordination and integration of NBS projects at EU level.
• Promote national/local scale planning and strategies that integrate NBS towards risk management and resilience.
• Perform ex-post assessment on implemented NBS regarding their contribution to the sustainability and resilience.
• The knowledge base on NBS effectiveness should be advanced with more demonstration projects (i.e. inclusion of NBS in Horizon Europe).
• Follow the frontrunner examples of NBS implementation in local and regional level and develop knowledge on good and bad practices.
• Combined and integrative socioeconomic and environmental strategies at local level can be achieved through NBS.
• Policy and strategies for risk management and resilience should take into account projections and scenarios of future challenges and not be based exclusively on today’s problems and needs.
• Multiple stakeholder groups must be involved in the finance and governance aspects of NBS.
• Integrate NBS into multiple key policy areas (e.g. infrastructure, spatial planning, economy).

Lessons learned and recommendations for action to advance the assessment framework of NBS impacts were also revealed:

• NBS monitoring methodologies can be significantly improved towards a holistic framework if the latest technological advancements from various scientific fields were used (e.g. Earth Observation, modelling, Big Data, citizen science)
• EU can facilitate NBS monitoring framework through the development of Copernicus programme towards more local scale datasets and the operationalization of the DIAS platforms.

• EU can aid to the alignment of NBS targets with EU Directives (i.e. Water Framework Directive, Biodiversity) and the harmonization of reporting with regards to disaster risk reduction to allow comparability.

• Mainstreaming NBS into policy is very much needed such as the comprehensive consideration of NBS into existing policy frameworks of spatial planning and land use, but also sector policies such as agriculture, health, energy, water, soil, etc.

• NBS guidelines and a global standard is crucial to foster legislation changes and influence European and National Policy centers.

Moreover, several future scientific and technological developments were revealed that would be valuable for the efficient evaluation of NBS impacts:

• Modeling capabilities and advancement of scientific quality

• Earth Observation technologies with enhanced spatial and temporal capacities

• Harmonization, standardization and open accessibility to data and methods through cloud-based platforms (e.g. Copernicus DIAS)

• Low-cost sensors with improved data quality

• Citizen science advancement (e.g. citizen observatories)

• Big data and data science

• NBS toolbox is advancing through several initiatives and projects

• Global standard of NBS is needed to define monitoring targets

• Connection of NBS with policy frameworks

• Multidisciplinary and co-design approaches
References


EC (European Commission). (2013). *An EU strategy on adaptation to climate change* [Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the


## APPENDIX 1. Summary of ThinkNature Case Studies

### 1. Yanweizhou Wetland Park - A resilient landscape, Jinhua- China

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type 2: NBS for sustainability and multifunctionality of managed ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges addressed</td>
<td>Climate change adaptation, Disaster risk reduction, Sustainable urbanization, Degraded ecosystem restoration, degradation of riparian habitat</td>
</tr>
<tr>
<td>Approach</td>
<td>Climate adaptation approaches, Ecosystem based management, Ecosystem based disaster risk reduction, Infrastructure related approaches</td>
</tr>
<tr>
<td>Scale</td>
<td>Regional</td>
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</table>

A wetland park was designed to preserve the remaining patch of a riparian habitat while providing amenities to the residents of the densely built Chinese city of Jinhua. This was achieved by creating a cohesive landscape that would connect the separated city to the natural riparian landscape, while allowing the park to flood occasionally.

The followed strategy is summarised below:

- Adaptive tactics preserve and enhance the remnant habitats (Water resilient terrain and plantings were designed to adapt to the monsoon floods)
- A water resilient terrain was created, which along with the planting design fulfil the need for temporary intensive and adaptable uses.
- Resilient bridges and paths ensure connection with the city even during flooding.

The multiple benefits include: Increased flood regulation and reduced risk of flooding, improved human health and well-being, improved connectivity, enhanced biodiversity, provision of recreational and cultural services.

### 2. Izta - Popo - Replenishing Groundwater through Reforestation, Mexico

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type 3: Design and management of new ecosystems</th>
</tr>
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</table>

Challenges addressed | Climate resilience, Water management, Public health and well-being, Potential for Economic Opportunities and Green Jobs
---|---
Approach | Climate adaptation approaches, Ecosystem based management, Ecosystem based disaster risk reduction, Ecological restoration, Infrastructure related approaches
Scale | Regional

The Puebla-Tlaxcala Valley is a region of Mexico where water supply is particularly critical. Securing a reliable water supply both for the large automobile industry operating in the area and for the local communities was a matter of great concern. Years of deforestation from illegal logging, livestock farming, and fires had led to increased water runoff, and loss of capture and storage in the groundwater table. Because of the above water retention was not sustainable. The planning team with the support of multiple stakeholders and with the active involvement of the local communities, proposed and implemented a system of natural infrastructure alternatives — trees, pits and earthen banks—to enhance rainwater capture: Approximately 300,000 Hartweg’s Pines, native to Mexico, were planted in 2008, on 300 hectares of land located at an altitude of up to 4,000 meters. To support the establishing pines, which grow very slowly, nutrient concentration in the soil was amended with organic material (compost). Pits and earthen dams were constructed to ensure a source of water was retained while the trees were establishing. The plantings, pits, and earthen banks will enable more than 1,300,000 cubic meters of additional water per year to be fed into the ground reserves in the source region. Over the long term, the additional biomass will also help sequester carbon dioxide and improve living conditions for the native fauna.
3. Medmerry, West Sussex coastal flooding - UK

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type 1: Better use of protected/natural ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges addressed</td>
<td>Climate change adaptation, Disaster risk reduction, Sustainable urbanization, Degraded ecosystem restoration</td>
</tr>
<tr>
<td>Approach</td>
<td>Climate adaptation approaches, Ecosystem based disaster risk reduction</td>
</tr>
<tr>
<td>Scale</td>
<td>Regional</td>
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</table>

This project is about establishing nature-based solutions for coastal resilience in Medmerry coastline located in south east England. Coastal flooding has long been a problem at Medmerry and a serious risk to the nearby towns of Selsey and Pagham. The previously existing defence, a 3km shingle bank, was subject to regular breach. As well as offering a deficient level of protection, the shingle bank's maintenance had become costly and unsustainable. An issue in the wider region of The Solent has been the loss of environmentally important coastal habitat, as a result of coastal squeeze. The impacts of development and flood defence infrastructure around the large, urbanised areas of Southampton and Portsmouth had caused local sea levels to rise and wetland and intertidal habitats to be lost to the sea. These challenges were addressed through sustainable flood risk management that provided a higher standard protection to the area, while creating a compensatory intertidal habitat. Initial actions were not received well by the local community. In response, the design team worked with them and apart from considering their inputs, created for them new access routes and viewpoints.

Coastal squeeze is an issue for other managed realignment schemes which can be subject to the same erosion processes as natural coastal wetlands. The same methodology of creating water banks can be applied to areas that face flood risk. Collaboration between a wide range of stakeholders was the key for the success of this project.

4. Montpellier, France: Agroforestry - Agriculture of the future?

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type 2: NBS for sustainability and multifunctionality of managed ecosystems</th>
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<thead>
<tr>
<th>Challenges addressed</th>
<th>Climate change adaptation, Climate change mitigation, Food and water security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
<td>Climate adaptation approaches, Ecosystem based management, Ecological restoration, Sustainable agriculture/agro-forestry/aquaculture</td>
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With the objective of making Montpellier agricultural systems more resilient to the effects of climate change (increasing temperatures or droughts, water and biotic stresses and more extreme events) an agroforestry scheme was adopted, combining trees and crops cultivation. The implemented solution allows for the diversification of farm activity, making use of the complementarity between trees and crops so that the available resources can be more effectively exploited, through a practice that respects the environment and with an obvious landscape benefit. Agroforestry leads to a 40% increase in productivity, while being less vulnerable to climate change and its related risks. Trees provide shelter to crops and reduce damages due to high temperatures. Biodiversity is increased, wind erosion is reduced and flooding damages are prevented. Soil and water quality are improved, also preventing erosion. However, agroforestry schemes are a long-term investment, as it takes time until trees mature and provide their functions. Agroforestry is usually not supported by short term investments.
5. Brague DEMO: Flash flood and wildfire hazards in a Mediterranean catchment, France

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<tr>
<td>Challenges addressed</td>
<td>Climate change adaptation, Disaster risk reduction, Ecosystem health, Human wellbeing and development, Sustainable urbanization, Degraded ecosystem restoration</td>
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<td>Approach</td>
<td>Climate adaptation approaches, Community based adaptation, Ecosystem based adaptation, Ecosystem based management, Ecosystem based disaster risk reduction, Ecological engineering, Ecological restoration, Infrastructure related approaches, Natural resources management, Sustainable agriculture/agroforestry/aquaculture</td>
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Dramatic floods in 2015 caused fatalities and significant damages in the area of Brague, France. To manage the risk of future torrential floods NAIAD project focused in this case study area. The flood risk was assessed taking into account climate change and cascading hazards. The effects of wildfire and urban sprawl on hydrology were analysed. Interviews and workshops were conducted to study risk and the perception of ecosystems. Updated methods to evaluate damages in flash flood context, to evaluate the benefits, co-benefits and negative impacts of NBS were provided. The results of the Brague catchment analysis can be transferred at various scales depending on the topic. For example, the effects of large wood on flood hazard aggravation are globally applicable. The links between wildfire, urban sprawling and hydrology are common in the Mediterranean, same as the damage curves for flash flood damage evaluation. The NBS co-benefits analysis are relevant for all the French coast.

The in-depth analysis of flash floods and related issues in this case study has enhanced understanding of large wood-related flood aggravation.
### 6. CONFLUENCE Project: Creating a Peri-urban Park in Prague, Czech Republic

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type 3: Design and management of new ecosystems</th>
</tr>
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<tbody>
<tr>
<td>Challenges addressed</td>
<td>Climate resilience, Water management, Coastal resilience, Green space management (including enhancing/conserving urban biodiversity, Air/ambient quality (to reduce UHI effect and/or to improve air/ambient quality), Urban regeneration, Social justice and social cohesion, Public health and well-being, Potential for Economic Opportunities and Green Jobs</td>
</tr>
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<td>Approach</td>
<td>Climate adaptation approaches, Ecosystem based management, Ecosystem based disaster risk reduction, Infrastructure related approaches</td>
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In an urban fringe southwest of Prague, surrounded by the riverine zones of two rivers and a biotope, a peri-urban park is established and administered. The objective is to create long term conditions for a metropolitan peri-urban park and introduce tools for coordinated and sustainable development of peri-urban landscapes. The undertaken activities and actions include partnerships in EU projects and initiatives, coalitions with local municipalities, international conferences and workshops and extended discussions with local stakeholders. This peri-urban park is expected to create a great potential for better natural values, to preserve and enhance the diversity of local biotopes and to create coordinated and sustainable administration a landscape that is currently very divided by various interests of local municipalities and private entities.

Cooperation and collaboration between the various actors are vital in peri-urban landscapes. Effective and constant communication is crucial, as is the connection between citizens and institutions. Systematic identification of problems should be prioritized and brownfields should be revitalized as they can become valuable public spaces. Creativity and simplicity are keys for easy implementation and increased acceptance by the public.
7. Green corridor in Passeig de Sant Joan, Barcelona (ENABLE project), Spain

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This green corridor in Barcelona is a highlighting case study for the classification type of “Type 2 - NBS for sustainability and multifunctionality of managed ecosystems”, in the category of “Extensive urban green space management”. As to its identity, it is a renovated section (its total length is about 1,2 km) of a corridor connecting the district of Gràcia and the Ciutadella Park and part of ENABLE project. The ‘Passeig Sant Joan’ is a promenade which connects the district of Gràcia with the Ciutadella Park, and it is in a district with the lowest availability of green space per inhabitant. Part of it was redeveloped into one of the first Green Corridors in Barcelona, aiming at increasing ecological and social connectivity within the city. This section follows a boulevard design that prioritizes vehicular use and commercial activities. The design distributes the use of the space between: wide sidewalks, two car lanes, and a segregated bidirectional lane for bicycles. Until then, this part of the promenade had been particularly neglected in terms of public space infrastructure, despite it being a key location, close to touristic attractions, very well connected and not far from the old city centre. The implemented solution improved this degraded area with restricted green space and includes not only walkways but also cycle and vehicle lanes. Consequently, this intervention in urban context provided mainly ecological and social impacts, but it also benefited the sector of economy too (i.e. commercial activities). Additionally, it serves the overriding goals of sustainable urbanization, climate change adaptation and risk management and resilience.
8. Paris Oasis Schoolyards programme, France

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With the aim of improving risk management and resilience, of developing climate change mitigation and in order to enhance sustainable urbanization the Municipality of Paris has launched the Oasis Schoolyards programme. Light-coloured, low carbon footprint substrates with a modular porosity will be applied on schoolyards. This way, the ground will have a cooling effect, to be further on enhanced with the additional use of rainwater through evapotranspiration. Trees, gardens, green walls and roofs, apart from providing shade, will also temper heat waves. Artificial installations, integrated to the design concept and combined with various cooling techniques and kinetic energy collection infrastructures on playgrounds, will cool down schools thus reducing their energy consumption. Lastly but not least, a healthy and stimulating learning environment is provided for pupils, while they along with residents of the surrounding communities are educated to risk culture on climate change.

The results of this initiative can be easily transported to other cities looking to adapt to climate change and the associated risks for repeated heat waves, by an urban and natural development while also considering social challenges.
9. Adaptation of Bratislava city to Climate Change, Slovakia

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In the past 10 years Bratislava, the capital of Slovakia, has experienced heat waves, droughts, fluvial and pluvial flooding and other extreme weather events. Taking action in order to protect citizens, to minimise the carbon footprint of the city and to implement green and soft adaptation measures that maximise the use of rainwater and green infrastructure, the city of Bratislava developed an Action plan for climate adaptation. Within this Action Plan are foreseen the creation of green areas, a water management scheme as well as Vulnerability Analysis and Planning Tools. City actions have been intensified by implemented activities and projects, also using international funds. The Action plan was integrated into the core strategic document of the city- The Social and Economic Plan. Later the commitment was declared at international level, when the city signed the EU climate change adaptation strategies - the Covenant of Mayors (in 2012) and the Mayors Adapt (in 2014). Adaptation measures are supported by communication activities with institutions, NGOs and the public. Co-creation and interdisciplinary research with the support of RESIN project, is put into practise for the development of practical and applicable tools for the implementation of climate adaptation strategies. Following vulnerability assessments, the focus was drawn on the effects of heat waves and flooding on quality of life. The city has implemented a small grant system for sustainable rainwater management installations on household level. Gradually the necessary adaptation and mitigation measures will be implemented to eliminate the impacts climate change to ensure adequate quality of living and natural environment, protection of health, property and long-term conditions for the quality of life of the citizens and visitors of the city, in active cooperation with external partners and city residents.
### 10. Basel: Green roofs - Combining mitigation and adaptation on measures, Switzerland

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A green roof initiative in Basel foresees a combination of financial incentives and building regulations in order to increase the coverage of green roofs throughout the city. Greening roofs in densely built-up areas can reduce storm water runoff by 17-20%, enhance biodiversity, mitigate the urban heat island effect and lower indoor temperatures as much as 5°C.

Green roofs are a type of green and blue space adaptation to climate change that brings multifunctional benefits: while the original entry point was energy-saving, the focus shifted to biodiversity, and then to the role of green roofs in adapting Basel to climate change. It is important to involve all stakeholders from the beginning of the initiative to address questions and concerns and ensure that everyone’s goals are being met. However, leadership of the project by a committed individual dedicated to the initiative’s success is fundamental. A comprehensive suite of mechanisms, from incentives to statutory regulations, ensures a wide uptake of green roofs.