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# Methodology for Mission Relevant NBS Assessment



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## EXECUTIVE SUMMARY

### *Policy context*

The Coordination and Support Action (CSA) project: ECOSystem-based governance with Danube lighthouse Living Lab for sustainable Innovation process –EcoDaLLi is featured based on the following:

1. EU Mission **Restore our ocean and waters by 2030: Atlantic, Arctic, Danube and Mediterranean lighthouses.**
  2. EU supported **Danube River Basin Management Plan.**
  3. EU projects related to **Danube restoration.**
  4. EU projects applying **Natural base Solutions, NBS,** approach for restoration.
- The same is incorporated in WP2 and T2.1.

As a CSA rather than a research project, EcoDaLLi's primary role is to support relevant stakeholders, potential Nature-Based Solutions (NBS) developers, and initiatives related to Mission Ocean and Waters, as well as the Danube Lighthouse Innovation Actions projects. Given the vast amount of literature available on NBS, D2.1 serves as a critical overview of various approaches, accompanied by comments and insights specifically related to NBS applications within the Danube River Basin and aligned with the project's objectives.

This deliverable offers a selection and adjustment of processes (methodology) tailored to meet the specific needs of NBS developers, stakeholders, and Innovation Action projects. The proposed methodology, along with its flowchart, includes several decision points designed to minimize unnecessary costs and labor should any issues arise during the process. This methodology has been developed in consultation with experienced partners involved in the EcoDaLLi project, as well as key stakeholders from the region.

### *Key outcomes*

#### **Review of publications**

The research for this document is performed as a comprehensive desk analyses, primarily of EU relevant projects and documents, but also those of UNO, IUCN and others. Dominant are publications dealing with NBS-related projects of urban areas. Water management is included in some of them and in the majority biodiversity issues are included. It is concluded that the NBS approach is still under development and recent publications were given priority.

#### **NBS definition**

The development of NBS, as a contemporary approach for ecosystem restoration is defined. The aim of NBS is to identify and solve environmental and social problems simultaneously. Recommended is the EU definition and procedure for evaluation and validation of NBS. Issues of infrastructure, green, blue and hybrid (combined with grey) are commented.





## Selecting challenges and indicators

The Societal challenges and benefits are selected as fundamental for NBS. Adequate challenge areas should be selected according to the restoration objectives. As, for NBS feature, besides being nature inspired, obligatory challenge areas are proposed:

1. Participatory Planning and Governance.
2. Health and Wellbeing.
3. New Economic Opportunities and Green Jobs.

The issue of selecting appropriate indicators is elaborated, and relevant publications are recommended. Criteria for the selection of appropriate indicators, e.g. RACER approach, are proposed.

It is important to emphasize that each NBS project is unique and requires a careful and thorough selection of societal challenges to be addressed, as well as appropriate indicators. Therefore, the proposed methodology offers guidance for various steps, which are explained in detail in the accompanying flowchart and explanatory table. The challenges specific to the Danube River Basin have been selected based on restoration objectives and key principles for identifying suitable indicators.





## Particularities of the proposed Methodology

The proposed methodology is basic, but, with adequate modification, can be applied to diverse topics and scales. It is designed to help NBS developers and practitioners but can be helpful for other groups too, such as decision-makers and authorities, etc.

The methodological framework is presented in the form of a simple flowchart, whereby the activities and documents are listed and explained in tables.

There are three project phases: preparatory – NBS assessment, restoration and operational. In the methodology two decision points are defined where termination of all further development in a project can be induced if necessary. This approach is aimed at reducing unnecessary expenses and labor.

Selected relevant terms and meanings for projects performing are based upon EC publications:

**Baseline Data Collection** describes an initial situation.

**Theory of Change** is a description of how the NBS intervention will reach its intended outcomes.

**Monitoring and Evaluation Plan** describes methods and timeline for following progress of the NBS project.



## 1. INTRODUCTION

In the **EU Mission Restore our ocean and waters by 2030: Atlantic, Arctic, Danube and Mediterranean lighthouses**, “lighthouses are” defined as “hubs and platforms supporting the development and deployment of transformative innovative solutions in all forms – technological, social, business, governance, ensuring fast progress towards the achievement of Mission objectives and important impact on society in the river and sea basins through science and technology”. For the Danube River Basin Lighthouse area, the following two major Mission targets have been set:

- 1) Restore at least 25 000 km of free-flowing rivers in Europe.
- 2) Contribute to nature restoration targets.

The **Danube River Basin Management Plan (DRBMP)**, 2009, Update 2021, also defined restoration needs and priorities. Longitudinal and lateral connectivity, as well as biodiversity enhancement, are salient points.

Thus, the main objective of the EcoDaLLi coordination and support action is to centralize Danube governance structures in terms of innovative solutions for improved ecological restoration, protection and preservation of the Danube River Basin by fostering a stronger innovation ecosystem within a well-connected Practices Living Lab System, supported by a digital portal, completely linked to the Mission Implementation Platform. Innovative solutions should open new opportunities for better water restoration, taking into consideration social innovation aspects, reducing climate change effects, and the reduction of risks and expenses.

Since the **Nature-based Solutions (NBS)** are a novel, permanently evolving concept, which is a kind of upgrading of UNO Sustainable Development Goals and European Green Deal, stimulating “*solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience*”, it is researched as a promising approach for reaching Mission and DRBMP defined targets.

In line with previous, within the EcoDaLLi project WP2 is defined:

### **NBS & eco-system connectivity for the protection and restoration of freshwater ecosystems and biodiversity**

*Activities here are meant to collect knowledge (best practices) regarding restoration of freshwater ecosystems with a deep understanding of role of Danube River ecosystem connectivity restoration (national & cross-border level). NBS assessment will gather relevant evidence across case studies on benefits & co-benefits generated by small & large scale NBS implementation for water related risks, longitudinal & lateral connectivity.*



The first task of the WP2, T2.1, is:

### **Methodology for Mission relevant NBS assessment**

*This task will develop a methodology for NBS assessment, building upon the existing knowledge in order to allow the identification of best practices regarding biodiversity conservation & restoration initiatives along the Danube river basin, including its delta. The results will be presented in D2.1.*

The methodology presented in this deliverable is aimed to help NBS developers and practitioners but should be helpful for decision-makers and authorities, as well. The methodology will be further tested and applied across the entire Danube River Basin, including all units, Upper, Middle and Lower Danube and Danube Delta.

From the practical point of view, the readers, NBS practitioners, decision makers etc., may start reading this Document from Chapter 6, and go back to appropriate chapter or reference when needed, as indicated in the Tab. 6.2 Activities.

In the Document, case studies and their results have been commented and some remarks, relevant to EcoDaLLi and the Danube River Basin Lighthouse area, are provided.

From a practical standpoint, readers – such as NBS practitioners and decision-makers – can begin their review of this document from Chapter 6. They may refer back to relevant chapters or references as needed, as indicated in Table 6.2, which outlines the activities. The document includes commentary on case studies and their results, along with remarks relevant to EcoDaLLi and the Danube River Basin Lighthouse area.

## 2. NATURE BASED SOLUTIONS

Nature-based Solutions (NBS) is a newly introduced, or reintroduced term, phrase. This idea is not new. Let's start with two antic sayings, which illustrate that the thinking about copying or having respect for nature in human behavior and activities is not new:

1. *If we accept nature as a guide we will never go astray.* Cicero, 106 BC till 43 BC.
2. *Let us keep to the way which Nature has mapped out for us, and let us not swerve therefrom.* Seneca, 4 BC till 65 AD.

Of course, the Greek *Physis* (used also *Fusis*), today nature, had a different more philosophic meaning in antic times.

Nature can be harsh sometimes as illustrated by such examples as volcano eruptions (well-known Santorini, death of the Minoan civilization, Vesuvius, Tambora (in 1815)), floods, drouths, insects' infestations, storms and earthquakes. Of course, these are not paragons for Nature-based Solutions.

### 2.1 COURSE OF NBS INTRODUCTION

The introduction of NBS has been duly demonstrated in the publication of the International Union for Conservation of Nature (IUCN) (**Cohen-Shachm et al., 2016**), fig. 2.1.

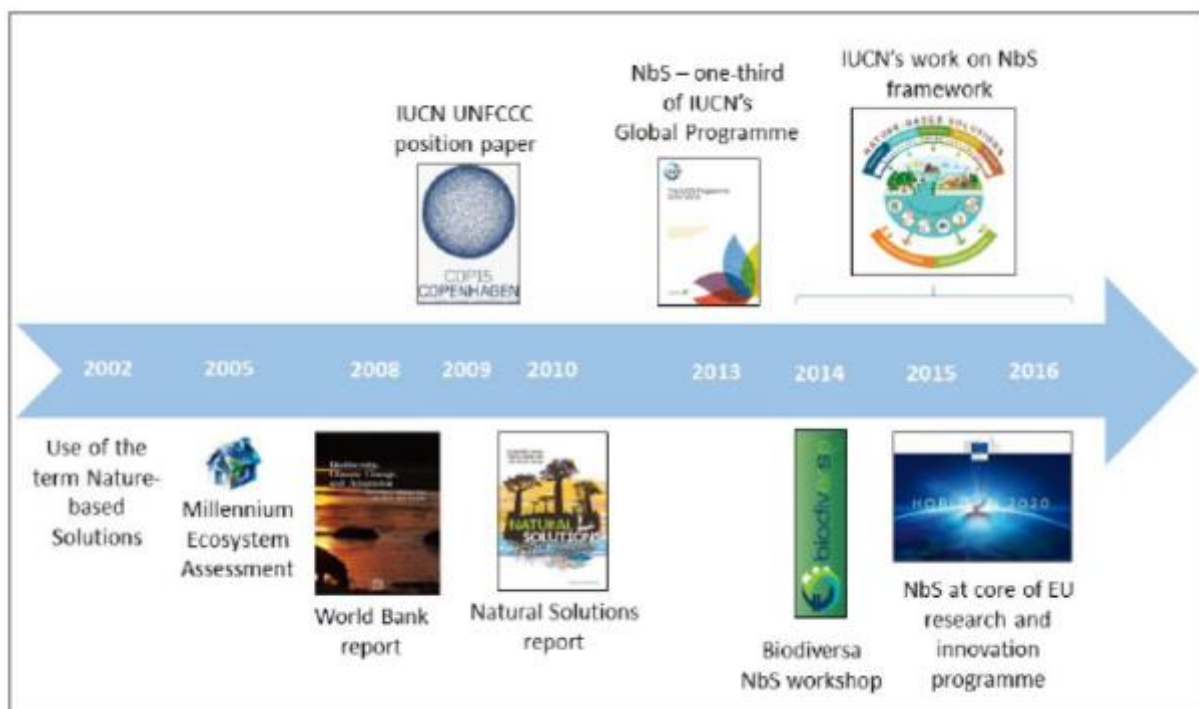


Fig. 2.1 Timeline of the development of the NbS (IUCN used for Nature-based Solutions acronym NbS) concept

In the same publications the Milestones in the development of NbS are defined, including the following publications and events:

- The World Bank report, *Biodiversity, Climate Change and Adaptation: Nature-Based Solutions from the World Bank Portfolio* (**World Bank, 2008**);
- IUCN’s position paper on the UNFCCC COP 15 (**IUCN, 2009**);
- *Natural Solutions: Protected areas helping people cope with climate change*, a report commissioned by IUCN-World Commission on Protected Areas, The Nature Conservancy, UNDP, Wildlife Conservation Society, the World Bank and WWF (**Dudley et al., 2010**);
- A workshop on ‘Nature-Based Solutions in a BiodivERsA context’ (**Balian et al., 2014**);
- A series of publications focusing on Nature-based Solutions (e.g. **Eggermont et al., 2015; Maes and Jacobs, 2015; European Commission & Directorate-General for Research and Innovation, 2015; Potschin et al., 2015**).

After 2016 the Nature-based Solutions have been widely developed and used.

## 2.2 DEFINITIONS OF NATURE-BASED SOLUTIONS

### Nature-based Solutions Initiative

The **Nature-based Solutions Initiative, Department of Biology**, University of Oxford, UK ([www.naturebasedsolutionsinitiative.org](http://www.naturebasedsolutionsinitiative.org)), a highly active institution, defined NBS (here used NbS) as follows.

*“Nature-based Solutions (NbS) are solutions to societal challenges that involve working with nature to deliver benefits for people and biodiversity. They include the protection, restoration or management of natural and semi-natural ecosystems; the sustainable management of productive land and seascapes; or the creation of novel ecosystems such as urban ‘green infrastructure’. Well-designed **NbS can contribute to tackling climate change and biodiversity loss**, whilst supporting many other sustainable development goals, but poorly designed schemes can have adverse impacts. Here we present four evidence-based guidelines for delivering successful, sustainable NbS with long term benefits for people and nature.”*

They described these four guidelines as follows:

01 NbS are not a substitute for the rapid phase-out of fossil fuels and must not delay urgent action to decarbonize our economies.

02 NbS involve the protection, restoration and/or management of a wide range of natural and semi-natural ecosystems on land and in the sea; the sustainable management of aquatic systems and working lands; or the creation of novel ecosystems in and around cities or across the wider landscape.

03 NbS are designed, implemented, managed, and monitored by or in partnership with Indigenous peoples and local communities through a process that fully respects and champions local rights and knowledge, and generates local benefits.

04 NbS support or enhance biodiversity, that is, the diversity of life from the level of the gene to the level of the ecosystem. This point is of particular importance for EcoDaLLi and is described more fully on their website in the following way:

*“Biodiversity underpins the societal benefits derived from NbS by supporting the delivery of many ecosystem services in the short term, reducing trade-offs among services (e.g. between carbon storage and water supply), and supporting the health and resilience of ecosystems in the face of environmental change, thus increasing their capacity to deliver benefits in the long term. To sustain ecosystem health, other location-specific ecological aspects must also be considered, such as ecosystem connectivity. Therefore, successful, sustainable NbS are explicitly designed and adaptively managed to provide measurable benefits for biodiversity and ecosystem health.”*

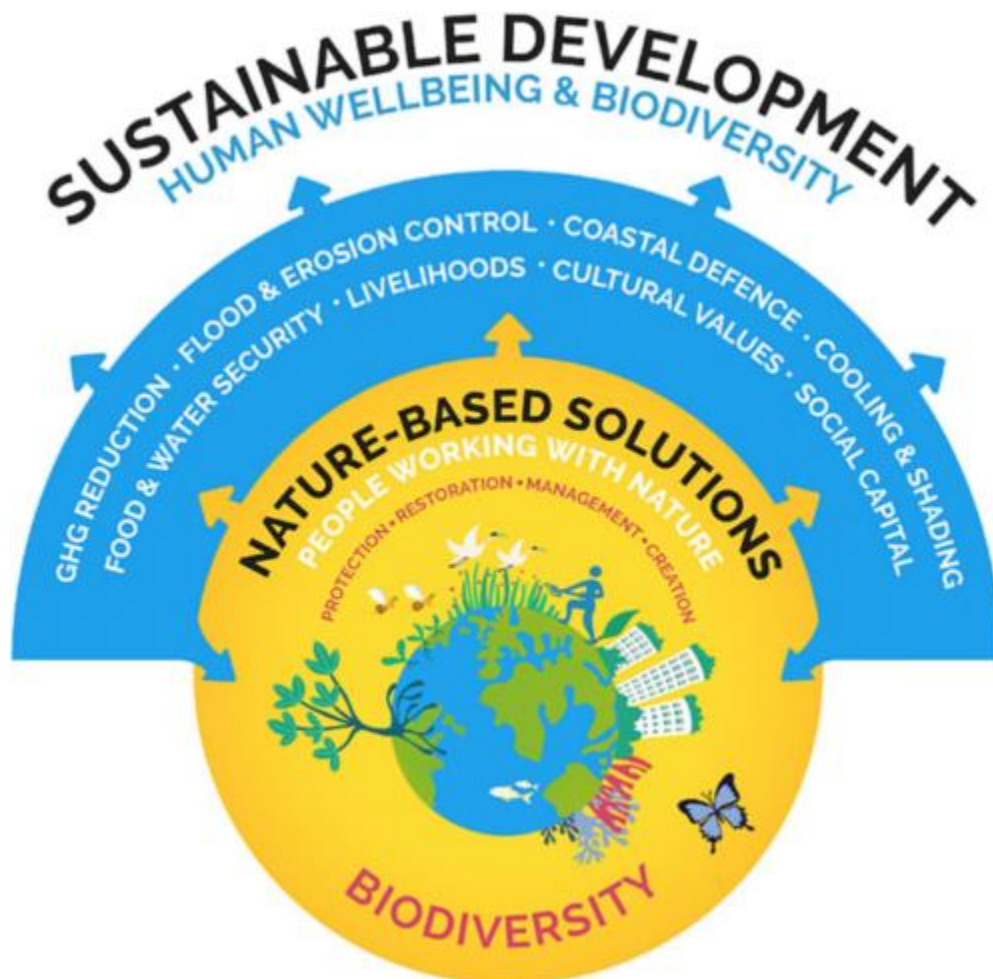


Fig. 2.2 Conceptual diagram of Nature-based Solutions

The NBS concept is presented in the above conceptual diagram Fig. 2.2.

*“People and nature, together (yellow circle), co-produce a variety of outcomes (ecosystem services or Nature’s Contributions to People, blue band) which benefit society; these benefits can, in turn, support ecosystem health (blue arrows). While the ultimate goal of NbS is to support sustainable development, including human health and wellbeing, the ecosystems that provide NbS must be healthy, functional and biodiverse if such benefits are to be provided in the long term.”*

The next figure, given by the same institution, presents a functional scheme of NBS.

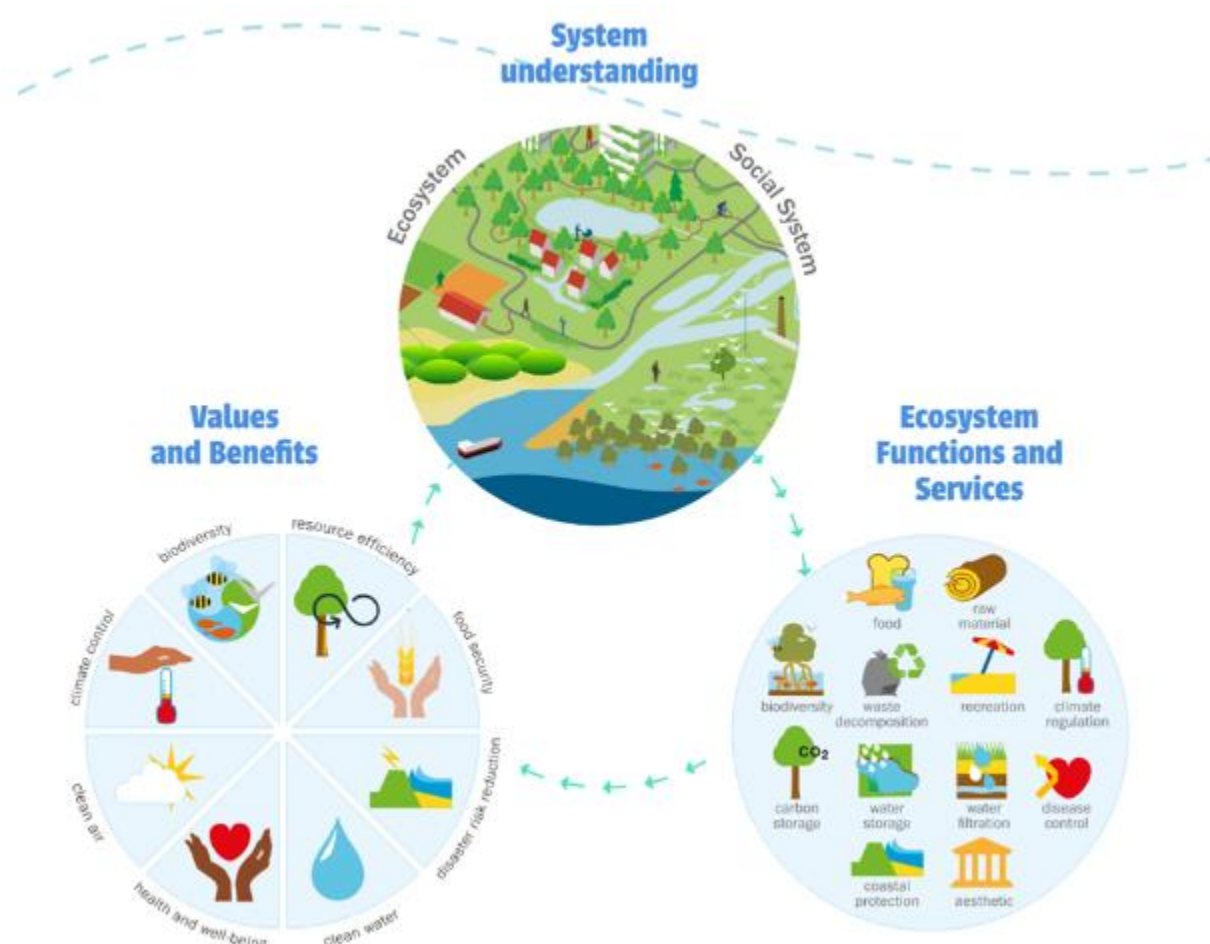


Fig. 2.3 Functional scheme of NBS

### International Union for Conservation of Nature

In the publication **Cohen-Shachm et al. (2016)** the International Union for Conservation of Nature (IUCN) presented its own definition of NBS.

*“Nature-based Solutions (NbS) use ecosystems and the services they provide to address societal challenges such as climate change, food security or natural disasters. IUCN defines NbS as: Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and **biodiversity benefits.**”*

Based on the four points listed in Table 2.1 eight further principles for NBS were developed:

1. NBS embrace nature conservation norms (and principles);
2. NBS can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions);
3. NBS are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge;
4. NBS produce societal benefits in a fair and equitable way, in a manner that promotes transparency and broad participation;
5. NBS maintain biological and cultural diversity and the ability of ecosystems to evolve over time;
6. NBS are applied at a landscape scale;
7. NBS recognise and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services; and
8. NBS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge.

Tab. 2.1 Basis used for principles (except 6 and 7), (Cohen-Shachm et al., 2016)

Basis for principle development	Principles developed
Nature-based Solutions are no substitute for nature conservation and they embrace nature conservation and its principles. At the same time, not all conservation efforts would necessarily be considered NbS.	Principle 1
NbS offer one group of solutions, among numerous others, to solve global societal challenges; NbS can complement, and be implemented alongside, other types of interventions.	Principles 2 and 8
A clear objective of NbS should be to support cultural and social components and values.	Principles 3, 4 and 5
NbS are context-specific, both in time and space. For example, although climate change is a global issue, the issue can be addressed in different ways, at different scales, and in different parts of the world. The appropriate NbS will need to be tailored to the specific conditions present.	Principles 3 and 4

Structural diagram is presented in Fig. 2.4.



Fig. 2.4 NbS as an umbrella term for ecosystem-related approaches, (Cohen-Shachm et al., 2016)

### European Commission (EC)

In Dumitru and Wendling (2021b) NBS are defined as follows(citation):

Nature-based Solutions provide integrated, multifunctional solutions to critical societal challenges. They are “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and interventions. **Nature-based Solutions must therefore benefit biodiversity** and support the delivery of a range of ecosystem services” (European Commission).

In the same publication the ECs structural diagram of NBS is presented.



Fig. 2.5 Nature-based Solutions address numerous societal challenges (Image © European Union, 2021)

Several societal challenges are described and those related to Biodiversity Enhancement are cited below:

*“Biodiversity loss and ecosystem collapse are among the greatest threats that our society faces in the near term. The implementation of Nature-based Solutions supports increased biodiversity, yielding benefits such as:*

- Reduced fragmentation/increased connectivity of natural areas;*
- Increased number of native species, including pollinators;*
- Increased species diversity of both flora and fauna.”*

In another publication, **Cardinali et al. (2021)** presented a slightly different definition of NBS (added some comments, i.e. clarifications).

*“The concept of Nature-based Solutions embodies new ways to approach socioecological adaptation and resilience, with equal reliance upon social, environmental and economic domains. Nature-based Solutions (NBS) were clearly described for the first time in the final report of the Horizon 2020 Expert Group (EC, 2015). The European Commission defines NBS as solutions that are “inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.”<sup>1</sup> Inherent in this definition is the idea that NBS must benefit biodiversity and support the delivery of a range of ecosystem services. Similarly, the International Union for Conservation of Nature (IUCN) defines NBS as “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits<sup>2</sup>”.*

<sup>1</sup> [https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions\\_en](https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en)

<sup>2</sup> <https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions>

Further citations are related to NBS in other EU documents.

*“Targeted NBS interventions are capable of enabling a more comprehensive implementation of the Floods Directive<sup>6</sup> via complementing national flood management strategies and flood risk management plans, e.g., through natural flood management schemes; Groundwater Directive<sup>4</sup> via interventions that reduce the burden on groundwater resources; and the Urban Waste-Water Treatment Directive<sup>5</sup> via infiltrating a portion of surface runoff. The overarching Water Framework Directive<sup>6</sup> enforces the implementation of the local river basin management plans to which NBS contribute directly and indirectly. Nature-based Solutions contribute directly to the Water Framework Directive (WFD) through integrated water management in terms of quality and quantity, which supports compliance with requirements for good ecological, physicochemical, and other statuses of surface waters and groundwater set by the WFD, as well as the active participation of stakeholders through co-design of NBS measures for water security.”*

<sup>4</sup> OJ L 372, 27.12.2006, p. 19–31

<sup>5</sup> OJ L 135, 30.5.1991, p. 40–52

<sup>6</sup> OJ L 327, 22.12.2000, p. 1–73

*“Biodiversity emphasis, as the core of the NBS concept, observes distinct ties with Natura2000 network, and the Birds<sup>7</sup>- and Habitats<sup>8</sup> Directives by directly re-establishing natural habitats and their connectivity, in compliance with the EU goals on green infrastructure, reducing pressures on the local biodiversity. The value of*

*NBS for biodiversity enhancement in an urban environment is outlined in the EU Green Infrastructure strategy<sup>9</sup>.*

<sup>7</sup> OJ L 20, 26.1.2010, p. 7–25

<sup>8</sup> OJ L 206, 22.7.1992, p. 7–50

<sup>9</sup> COM/2013/0249 final

*“Adaptation to the effects of climate change is equally reflected in the EU Bioeconomy Strategy and the EU Circular Economy Strategy<sup>10</sup>, both major constituents of the European Green Deal<sup>11</sup>. NBS can contribute to circularity by, e.g., facilitating the recycling or productive re-use of organic materials, or rainwater capture and re-use. The latter can significantly advance, for example, the Water Scarcity and Droughts Policy<sup>12</sup>, while helping to advance the EU circular economy action plan<sup>13</sup> and approach through the water cycle.”*

<sup>10</sup> COM/2020/98 final

<sup>11</sup> COM/2019/640 final

<sup>12</sup> COM(2007) 414 final

<sup>13</sup> [https://ec.europa.eu/environment/strategy/circular-economy-action-plan\\_en](https://ec.europa.eu/environment/strategy/circular-economy-action-plan_en)

## **NBS in EU (research and innovation) policies**

Nature-based Solutions support some of the key EU policy priorities, particularly the European Green Deal, biodiversity strategy and climate adaptation strategy, as a way to foster biodiversity and make Europe more climate-resilient. The European Commission actively pursues policy dialogues and outreach initiatives at the EU and global level to foster engagement and develop a broad knowledge base. One of the goals of research and innovation policy is to position the EU as a leader in innovating with nature to achieve more sustainable and resilient societies.

Some of the EC policy goals are:

- provide evidence for Nature-based Solutions,
- improve framework conditions for Nature-based Solutions at EU policy level,
- develop a European research and innovation community,
- advance the development, uptake and upscale of innovative Nature-based Solutions,
- mainstream Nature-based Solutions in international research and innovation.

The European Union also considers NBS as an opportunity to foster innovation and competitiveness, both in domestic and international markets.

In Horizon Europe, Nature-based Solutions will be further tested, deployed, promoted and their benefits and impacts assessed, notably via EU Missions.

## **NBS in an International policy context**

The Hyogo Framework for Action (HFA) 2005–2015 (**UNISDR, 2005**), is an international agreement under the auspices of the United Nations International Strategy for Disaster Reduction (UNISDR), aimed at reducing the loss of lives, damage to properties and overall economic impact caused by natural hazards to enhance the sustainability of nations and communities (**Quevauviller and Gemmer, 2015**). A lack of sufficient quantitative data necessary to evaluate various options and actions to mitigate the impacts of natural hazards was identified in the HFA. This lack of data has made monitoring the progress of disaster risk

reduction (DRR) and climate change adaptation (CCA) particularly challenging (**UNISDR, 2011**). This Handbook contributes directly to the acquisition of consistent and accurate data concerning impacts of actions undertaken to address natural hazards in a systematic way.

## **NBS RELEVANCE FOR THE DANUBE LIGHTHOUSE AREA**

The most significant characteristics of Nature-based Solutions are:

1. Contribution to solving environment, ecosystem, and biodiversity problems.
2. Simultaneous enhancement of human wellbeing.
3. Solutions are inspired and supported by nature.

Furthermore, these solutions should be cost-effective. This aligns with concepts such as Nature Based Economy, Nature Positive Economy, and Nature Based Enterprise (**Mcquaid et al., 2022**).

The following statement is cited from **Cohen-Shacham et al. (2016)**:

“NbS is a relatively ‘young’ concept, still in the process of being framed. There is a need now to deepen our understanding of NbS and confirm the principles upon which NbS is based, in order to move towards an operational framework that can guide applications of the NbS concept.”

This statement remains relevant today.

The solutions should be primarily research and innovation-based (**Anonymous, 2015**), opening new fields for researchers and developers. Reputable publisher Elsevier, launched a new journal ***Nature-Based Solution*** in 2021 illustrating how this approach is highlighted.

Based on the previous reviews, the most appropriate definition of NBS to be used for the Danube Lighthouse, is the European Commission definition, cited from **Dumitru and Wendling (2021b)**. Whenever feasible, NBS represents a valuable strategy for future restoration efforts in the Danube River Basin.

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### 3. REVIEW OF METHODOLOGY AND METHODS

In this section results of publications on NBS deemed relevant for the development of the methodology (method) are presented. In these publications, different terms are used to describe these issues, including *framework* and *approach*. To avoid confusion, the simplified description of these terms cited from web are presented below.

**Methodology** is the analysis of all the methods and procedures of the process.

**Method/s** are just behaviors or tools used to select a research technique.

**Framework** is a structured approach to problem solving.

**Approach** is generalized and tells one how to go about a problem.

In the following the term methodology will be used for the development of all NBS steps, as written in Task 2.1.

The term method, i.e. methods, is used for defining indicators and data selected for assessment.

#### 3.1 GENERAL COMMENTS, REMARKS

##### Planning (starting) projects/interventions

Every new project or intervention starts with the identification of existing or perceived problem(s), followed by elaboration and identification of potential solutions. This should be the case with Nature-based Solution as well. However, in this case, it should additionally be proven that the solutions are in line with NBS rules, standards, expectations. In order to achieve this attestation, verification and validation of all planned solutions should be performed.

An interesting critique on the evaluation of project/intervention relevance concerning NBS is presented by **Sowińska-Świerkosz and García (2022)**, citation:

*“Although nature-based solutions (NBS) have been promoted as a key tool for solving diverse environmental and societal problems, the concept and its practical applications remain unclear. This ambiguity is linked to the fact that the NBS concept has emerged from the integration of multiple scientific fields. In addition, there has been a delay in establishing clear standards for NBS, hence a number of actions that today would be seen as complementary or related measures, are frequently branded as NBS.*

*These definitions, however, are somewhat general and blurry and fail to clearly indicate which green and blue solutions should be regarded as NBS. As a result, there is a constant debate on the scope and types of interventions that can be classified as NBS. Furthermore, the concept’s ambiguity has already been stressed by many researchers; United Nations Environmental Programme. Such results first from the fact that any definition of NBS involves integrating multiple scientific fields and experts with different backgrounds think about NBS from the point of view of their own base discipline.”*

These are realistic and proper comments on the topic. The authors further proposed the scheme presented in Fig. 3.1.

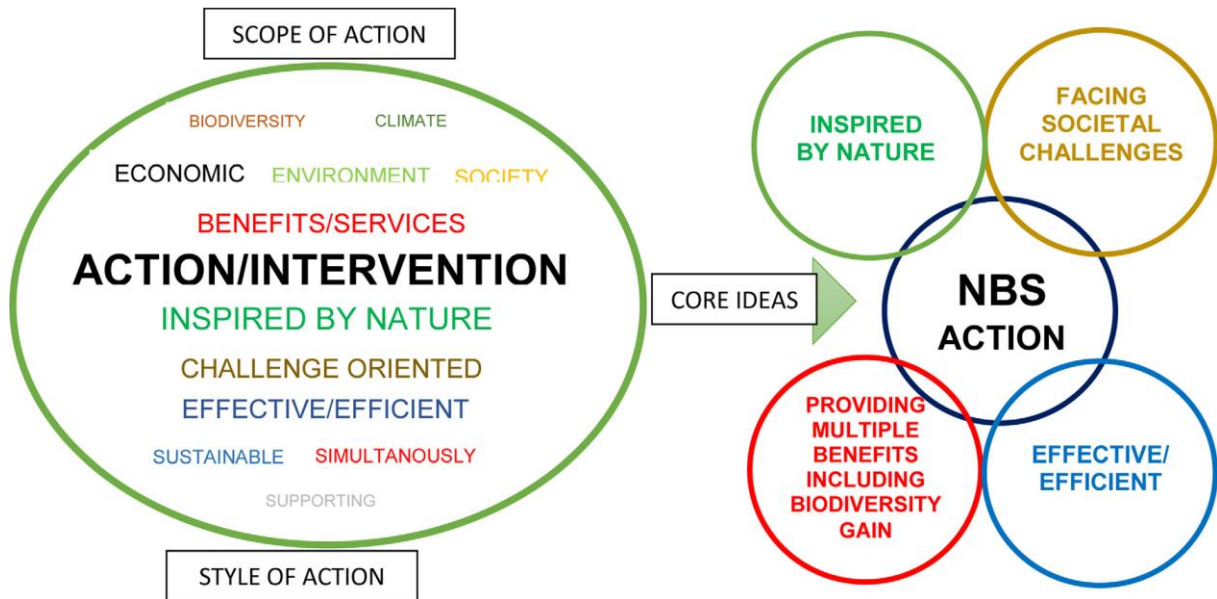


Fig. 3.1 Schematic representation of the process used in this study of core ideas behind NBS definition

This scheme summarizes the idea properly but excludes the necessity of scientifically justified Nature-based solution although referenced previously by the authors. This crucial point is only vaguely referenced in the phrase **Inspired by Nature**. But, how to know what this means, and who can validate it?

**Albert et al.** (2021) considered numerous references related to the definition of NBS. It was concluded:

*„In spite of respective expectations we did not find the NBS concept to be easily applicable as a boundary object for stakeholders, some of whom interpreted it as too biased towards nature conservation...”*

A similar statement was mentioned by other authors, e.g. **Nesshöver et al.** 2017).

It was further noted:

*“We also identified disconnects between the scientific NBS discourse, where definitive clarity is needed, and the **debate in practice**, where real-world problems need to be addressed regardless of the applied concepts.”*

Another very important point was omitted: The need of using **innovative**, scientifically grounded solutions. New and innovative solutions are needed.

The project tackles river restoration and the principles and criteria for NBS are presented in Fig. 3.2. The authors have criticized definitions of NBS, but their own is arguably inadequate, or, at least, not universal.

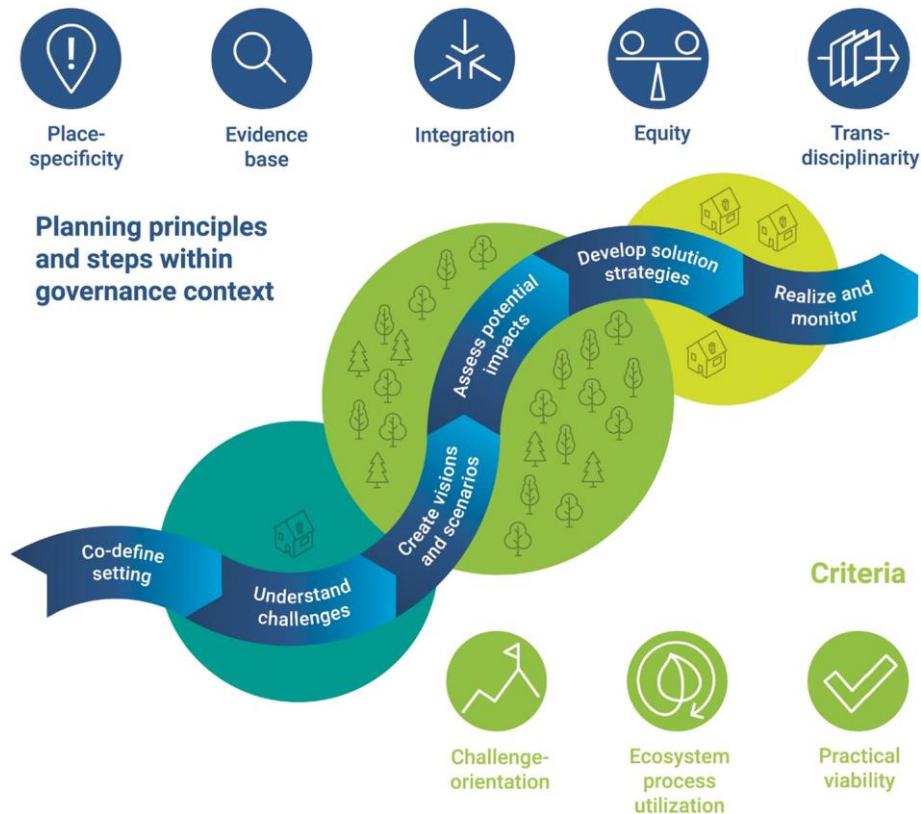


Fig. 3.2 Conceptual framework of principles and steps for planning Nature-based Solutions (NBS) as well as key NBS criteria

The first four steps in project development can be treated as a **conceptual solution**, with the third one, creating visions and scenarios, being the most important for providing NBS relevance.

### **Conceptual solution, team**

Who shall initiate project/intervention? Who should initiate and induce the application of NBS? Depending on type and scale of the project/intervention it could be a single.-person, team or institutional initiative.

This crucial first step was mentioned in only a few publications.. **Dushkova and Haase (2020)** listed potential initiators of NBS as: public, private, public-private, governmental institutions, scientific or technical advisors. The same were listed as stakeholders.

Who are initiators of the project/intervention depending also on project's scale and volume. It can range from individuals, companies to regional, national and EU-level public authorities.

For the assessment of conceptual solution, as well as all other activities, core teams should be established, and supported by auxiliary entities, experts, professionals and advisors.

It is important to involve individuals or institutions with experience in NBS from the very beginning.

Creators of conceptual solution should document the problem identified, by providing relevant and plausible data (database), defining the timeframe (short or long term, maybe both)

and describing the expected advancements and solutions. Both the problems and the results, should be measurable or quantifiable.

This principle has been explicitly, or implicitly, mentioned in some of the references. A typical example is given by **Raymond et al.** (2017), (will be discussed later) who established an Expert Working Group on Nature-based Solutions (EWG) for the project.

### **Scale**

NBS are typically distinguished into small and large-scale solutions. Large scale solutions are dominant, since the CAPEX (capital investment costs) are higher and can more easily finance large teams of experts and others.

Other terms are: multi-scale, spatial scale, global, micro, local, city scale, etc. In some cases, scaling up and varying scale are mentioned if the replication of a developed solution is planned.

No mentions of micro-scale projects and only few mentions of small scale projects were found. This raises the question: Could such projects be supported and treated as NBS? Could some innovative engineering solution be declared as NBS, or, at least be defined as tools contributing to the realization of NBS? One positive example is presented on <https://rivercleaning.com/>. The project was financially supported by EU. It has developed engineering solutions for cleaning rivers and some other water bodies (i.e. channels and lakes) by removing plastic and oil. The project team stated that 80% of ocean plastic is coming from rivers. The following picture is an excerpt from a web site video about their patented solution for plastic collection.



### **Stakeholders**

The most frequently mentioned stakeholders are: public authorities (from settlements to EU level), citizens, private sector and researchers. Other groups are: investors, financial sector, practitioners, consultants, statistic authorities, technology providers, NBS implementers, decision makers, policy makers, NGOs etc. covering a really broad part of society.

Small and medium enterprises are not mentioned in the available references, especially not as initiators of NBS.

The term stakeholder was criticized by **Alva** (2022) as follows:

*“One of the most pervasive words across these texts and all NBS literature, even inside academia, is that of ‘stakeholder’, which is deeply rooted in the business mindset. While it is true that there are many beings and systems with high stakes in this topic, this pernicious word is flooding the NBS field with neo-liberal ideology. Alternatives like ‘involved groups’, ‘community/team members/participants/contributors’ would be more appropriate.”*

## 3.2 REVIEWED EXAMPLES

The following section presents a review of significant publications related to the methodology and methods in chronological order.

### 3.2.1. Project EKLIPSE

In **Raymond et al.** (2017) results are presented, by the EKLIPSE established, Expert Working Group, on Nature-based Solutions to Promote Climate Resilience in Urban Areas. (EKLIPSE, <https://eklipse.eu/>, was created in 2016 to help governments, institutions, businesses, and NGOs make better-informed decisions when it comes to biodiversity and ecosystem services in Europe.)

Although the topic is related to resilience of urban areas, an interesting and serviceable approach for assessment and evaluation of NBS is presented. The publication contains a useful glossary and some of the terms will be cited here.

The Expert Working Group (EWG) established the following objectives:

- 1) To develop an impact evaluation framework with a list of criteria for assessing the performance of NBS in dealing with challenges related to climate resilience in urban areas.
- 2) To prepare an application guide for measuring how NBS projects impact the identified indicators in delivering multiple environmental, economic and societal benefits.
- 3) To make recommendations to improve the assessment of the effectiveness of NBS projects, including the identification of knowledge gaps according to the criteria presented in the impact evaluation framework.

In relation to **objective 1**, the EWG developed a framework that enables the assessment of impacts related to specific NBS actions within and across 10 challenge areas. Fig. 3.3.

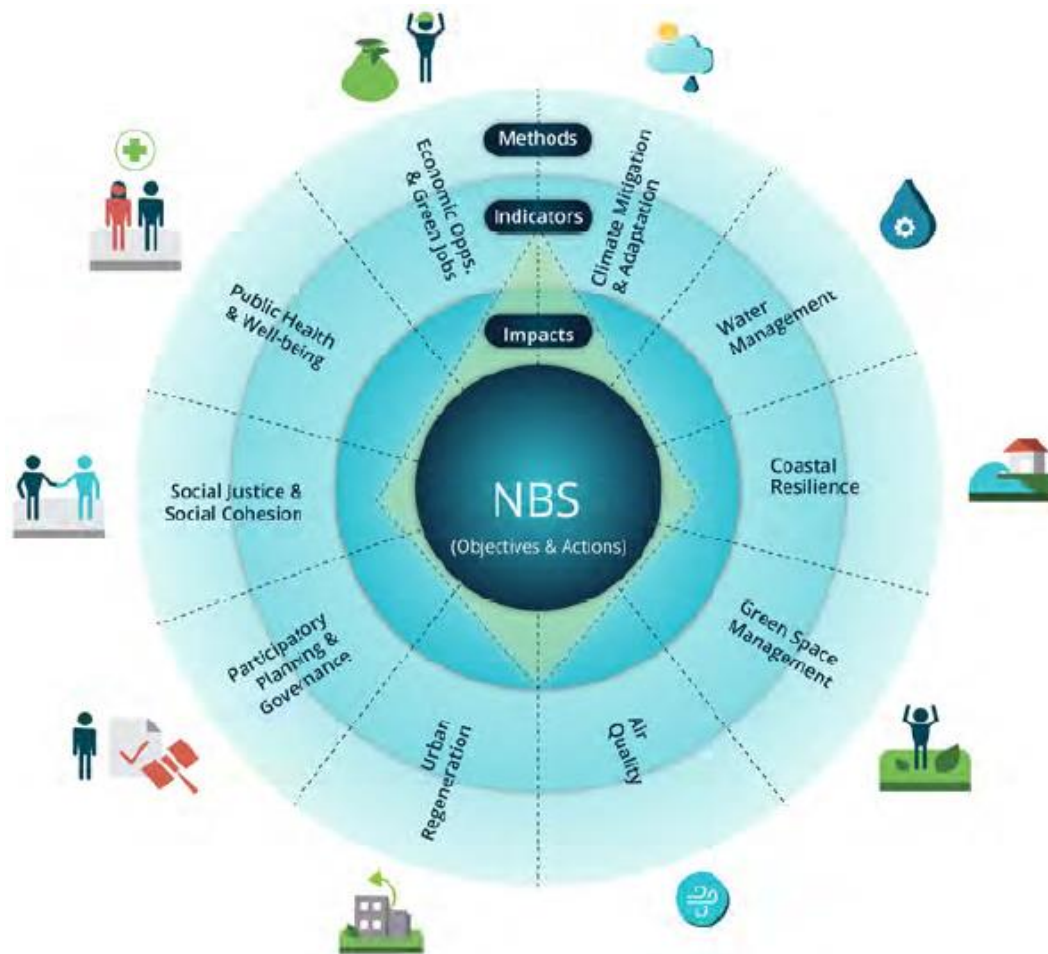


Fig. 3.3 The 10 climate resilience challenges considered in this impact assessment framework

Based on the 10 challenges, related to **objective 2**, the following issues, in order to declare a project as NBS, should be elaborated:

- 1) How each challenge could be addressed;
- 2) Which components of each challenge are relevant and will be addressed;
- 3) The geographical and temporal scale of the action and its effect;
- 4) Which indicator(s) will be appropriate to measure the effectiveness of individual actions in addressing each challenge;
- 5) Which methods are available, suitable and feasible for the measurement of the indicators;
- 6) What baseline will be used, including measurements that should be taken prior to the commencement of any action, so that effectiveness can be measured;
- 7) How to identify interactions between actions, and how to capitalize on the opportunities presented by co-benefits and tackle any trade-offs between conflicting desired effects.

The **objective 3** is a roadmap for the assessment of NBS impacts, including a summary of knowledge gaps and associated future research and practice directions. The results are presented in the publication.

The EWG performed a comprehensive literature study, combined with expert consultation within and outside the EWG. The EWG selected 10 challenges from the expert report on NBS supported by DG Research and Innovation (**European Commission**, 2016) and a recent review of NBS frameworks (**Kabisch et al.**, 2016):

- 1) Climate mitigation and adaptation;
- 2) Water management;
- 3) Coastal resilience;
- 4) Green space management (including enhancing/conserving urban biodiversity);
- 5) Air/ambient quality;
- 6) Urban regeneration;
- 7) Participatory planning and governance;
- 8) Social justice and social cohesion;
- 9) Public health and well-being;
- 10) Potential for new economic opportunities and green jobs.

The challenges highlighted are of interest for the EcoDaLLi project.

The study is performed in three stages, Fig. 3.4. The volume of literature was:

First stage

- 320 peer-reviewed articles or books all read to at least abstract level.
- 1223 pieces of grey literature
- Grey-literature further screened based on titles, 10% read to at least summary level.

Second stage

- 247 unique articles, books or reports not identified in Stage 1 all read to at least abstract or summary level.

Third stage

- Narrative synthesis.

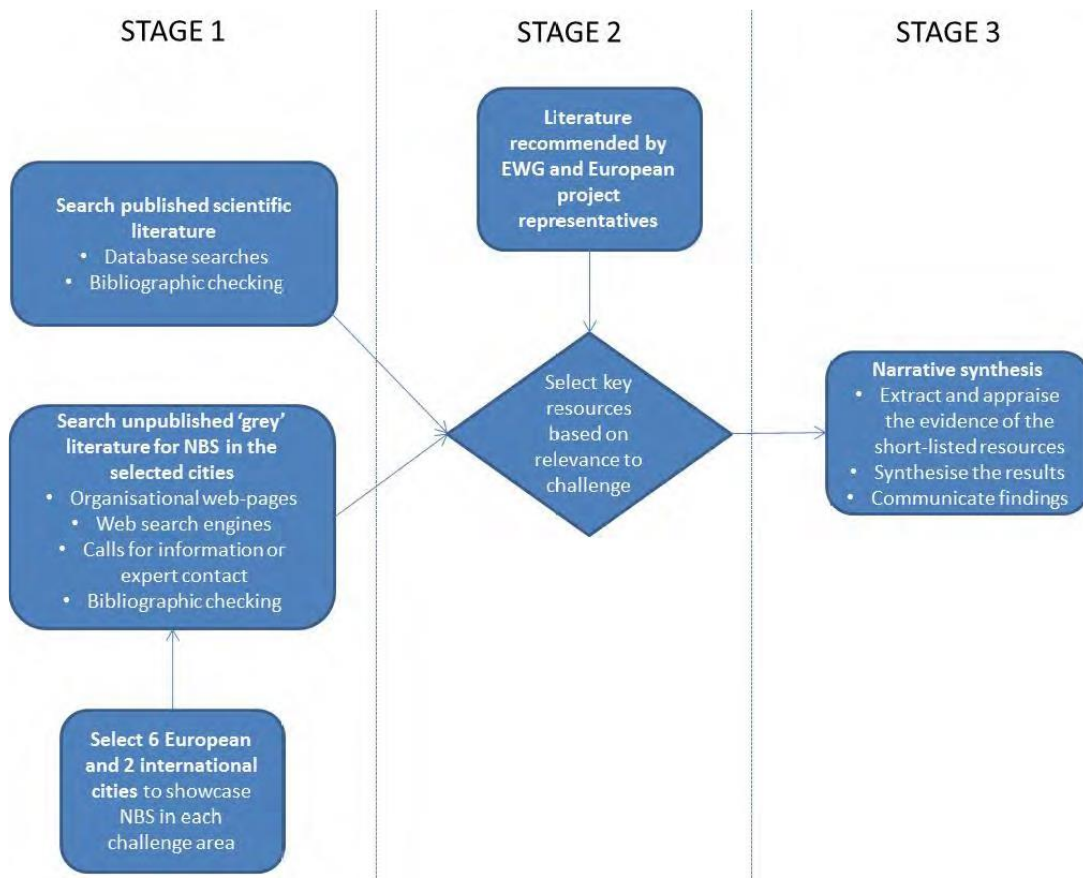


Fig. 3.4 The three stages of the quick scoping review of the literature

This activity enables involvement of scientific and professional knowledge relevant to the project. However, as in previously mentioned publication the importance of innovations was not emphasized (indirectly in conclusions). The work started with comparison of Mapping and Assessment of Ecosystems and their Services (**European Commission, 2020**), and NBS relevant to societal challenges, Fig. 3.5.

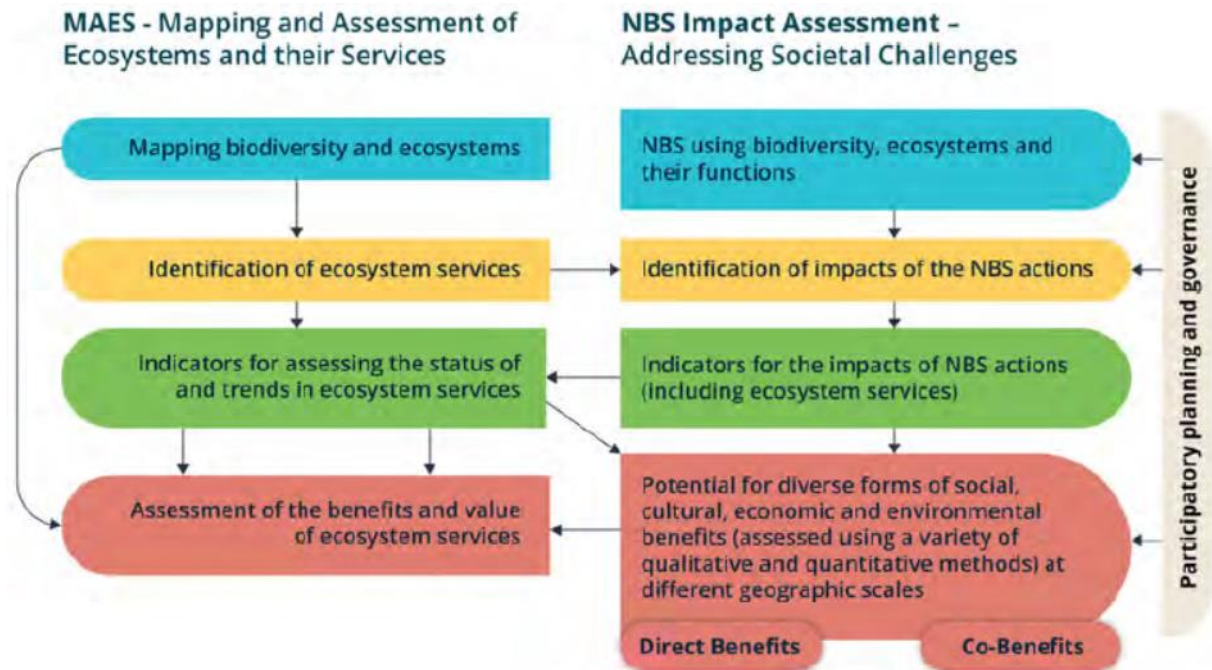


Fig. 3.5 Flow diagram showing the relationships between the NBS impact assessment framework and MAES

NBS may have the potential to transform an urban area with an impermeable surface into an urban water body with renewed ecosystems, containing water flows and functions which can be integrated into the wider catchment. Nature-based or combined grey-green solutions for water management can also provide additional co-benefits regarding:

1. Urban biodiversity
2. Improving the urban environment and living conditions, with benefits for human well-being and quality of life etc.

The work has been continued by defining challenges, of which the ones relevant for EcoDaLLi are listed below:

- Challenge 2: Water Management
- Challenge 4: Green Space Management (including enhancing/conserving urban biodiversity)
- Challenge 7: Participatory Planning and Governance
- Challenge 9: Public Health and Well-being
- Challenge 10: Potential for Economic Opportunities and Green Jobs

Some further examples of activities potentially of interest for many other projects are listed here.

## Potential actions and Expected Impacts

Tab. 3.1 Potential climate adaptation actions at the meso and microscale and expected impacts

Potential actions	Expected impacts
<ul style="list-style-type: none"> <li>Increasing the area of (or avoiding the loss of) vegetation and particularly tree cover.</li> <li>Increasing green walls and roofs to cool down the city through outdoor energy management using shading and the latent heat of evapotranspiration of plants and soils.</li> </ul>	<ul style="list-style-type: none"> <li>Maximize cooling effect by evapotranspiration and shading, thus reducing local temperatures and ameliorating heat island effects and heat stress (Alexandri and Jones, 2008; Fioretti et al., 2010; Kazmierczak, 2012).</li> <li>Securing long-term carbon storage in vegetation and soil and avoid carbon emissions from land-use changes (global impact).</li> <li>Increased energy savings at building and street level through the insulating effect of plants (Alexandri and Jones, 2008; Zinzi and Agnoli, 2011).</li> <li>Reducing wind speed and thus wind chill in cold climates.</li> </ul>

## Indicators

In this paragraph the selected indicators are listed as exemplary (cited):

- Objective of the action – which challenge(s) it is seeking to address;
- Type of action – all NBS will involve some element of biodiversity, but will differ in their attributes and thus appropriate methods for measurement;
- Potential expected impacts, both direct and indirect, and both positive (synergies) and negative (trade-offs or disservices);
- Resources and skills available for measurement of the impacts;
- Scale of analysis, which influences the availability and relevance of data for specific indicators

## Scale

For these type of projects, dealing with urban area, two groups of scales are selected:

**Mesoscale:** Region, Metropolitan, Urban

**Microscale:** Street, Building

In the subchapter **Methods for assessing the impacts of NBS** four types of assessment are listed, which could serve as an example for users.

- Monetary assessments
- Non-monetary assessments
- Environmental assessments
- Integrated approaches (including co-benefits)

The publication is finished with **Application Guide for the Assessment of the Effectiveness of NBS Projects and Conclusions.**

Citation of the Conclusions final paragraph:

*“In fact, how to integrate NBS impact assessment with NBS implementation remains another important research gap. Impact assessment and implementation have traditionally occurred separately, but coproduction processes are needed for bridging these two fields. This may involve considering the specific types of capitals (e.g., natural, built, financial), capabilities and agency that are required to implement specific types of NBS alongside the environmental, social and economic co-benefits of NBS.”*

The presented **Glossary of Key Terms** can be helpful. Here, excerpts of three items are presented.

Term	Definition	Key references
NBS Effectiveness	The degree to which objectives are achieved and the extent to which targeted problems are solved. In contrast to efficiency, effectiveness is determined without reference to costs. e.g., <ul style="list-style-type: none"> <li>• Does the NBS lead to enhanced climate resilience in the urban area?</li> <li>• Does the NBS lead to environmental benefits?</li> <li>• Does the NBS lead to social benefits?</li> <li>• Does the NBS lead to economic benefits?</li> </ul>	Adapted from Oxford Dictionary (2016)
Robust NBS	An NBS that achieves the expected objectives and solves the targeted problem under different uncertain future situations.	
Trade-offs	Situations in which one ecosystem service increases and another one decreases. This may be due to simultaneous response to the same driver or due to true interactions among services.	Potschin et al. (2016); Bardosa et al., 2016)

**Final comments:**

The evaluation of project/intervention relevance regarding NBS is rather positive and clearly described and presented. The publication contains many useful instructions, relevant for almost all NBS. NBS assessment is mentioned and mostly described.

It does, however, miss a few interesting steps: at the very beginning it is omitted to explain who is the initiator of the project. Furthermore, the physical-engineering aspects of the project/intervention are not explained. Additionally, legal issues. e.g. who is the owner of location, land, where project will be performed, should be considered as well as legalization of performed activity, and long term sustainability.

**3.2.2 IUCN Standards**

The reputable institution IUCN **International Union for Conservation of Nature and Natural Resources**, deeply involved in NBS, developed a kind of methodological approach and tool for NBS developer and users the so called Global Standards for Nature-based solutions.

Institution FEBA (Friends of Ecosystem-based Adaptation), <https://friendsofeba.com>, gathers a group of diverse institutions interested in ecosystem adaptation, including IUCN. The

term Ecosystem-based Adaptation (EbA) was first developed by FEBA in 2008, and presented in 2009. This concept was officially defined in 2009 (FEBA, 2017), Fig. 3.6.

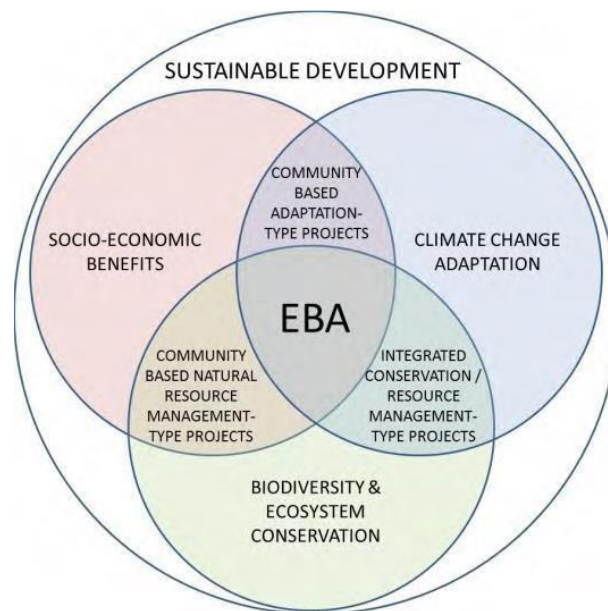


Fig. 3.6 Ecosystem-based Adaptation (EbA) encompasses the linkages among climate change adaptation, biodiversity and ecosystem conservation, and the generation of socio-economic benefits

Obviously, this can be seen as a forerunner of NBS. In the same publication, a method for project/intervention identification as EbA is presented. The assessment, “*Is this approach EbA or not?*” is based on five Criteria, Quality Standards, and Indicators.

In **Anonymous 2020a** a similar approach is demonstrated. The aim of “Standard” is stated there, citation (in all cited parts is used abbreviation NbS, instead of NBS, as written in this publication):

*“As NbS enters into policy and is adopted by projects on the ground there is a pressing need for greater clarity and precision of what the concept entails and what is required for it to be deployed successfully. Without this, the application of NbS could result in inconsistent and ungrounded applications. The Standard, therefore, also provides a systematic learning framework so that lessons can improve and evolve the applications, leading to greater confidence in NbS among decision makers.”*

Further are mentioned target groups, potential users and applications:

*“IUCN envisions that national governments, city and local governments, planners, businesses, donors, financial institutions including development banks and non-profit organisations will all be primary users of the Standard. The Standard can be used by stakeholders working in a range of settings from protected areas to productive landscapes to urban areas, and across different regions and in modified or intact ecosystems. Users can apply the Standard to both large-scale and small-scale interventions.”*

The Standard were created by the International Standard Committee and Scientific committee (groups within IUCN). It was planned to communicate with users via National/Regional hubs as presented in Fig. 3.7.

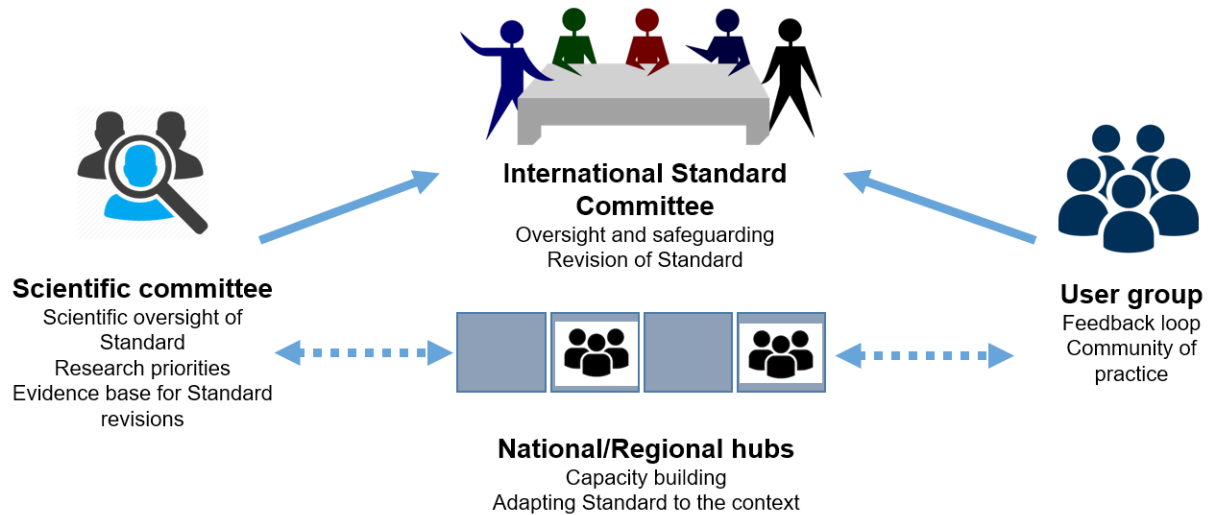


Fig. 3.7 Governance of the Standard through an International Standard Committee © IUCN

The Standard consists of 8 Criteria and 28 Indicators as follows.

**Criterion 1: NbS effectively address societal challenges**

**Indicators**

- 1.1 The most pressing societal challenge(s) for rights-holders and beneficiaries are prioritized
- 1.2 The societal challenge(s) addressed are clearly understood and documented
- 1.3 Human well-being outcomes arising from the NbS are identified, benchmarked and periodically assessed

**Criterion 2: Design of NbS is informed by scale**

**Indicators**

- 2.1 The design of the NbS recognises and responds to interactions between the economy, society and ecosystems
- 2.2 The design of the NbS is integrated with other complementary interventions and seeks synergies across sectors
- 2.3 The design of the NbS incorporates risk identification and risk management beyond the intervention site

**Criterion 3: NbS result in a net gain to biodiversity and ecosystem integrity**

**Indicators**

- 3.1 The NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss
- 3.2 Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed
- 3.3 Monitoring includes periodic assessments of unintended adverse consequences on nature arising from the NbS
- 3.4 Opportunities to enhance ecosystem integrity and connectivity are identified and incorporated into the NbS strategy

#### **Criterion 4: NbS are economically viable**

##### **Indicators**

- 4.1 The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented
- 4.2 A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies
- 4.3 The effectiveness of the NbS design is justified against available alternative solutions, taking into account any associated externalities
- 4.4 NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance

#### **Criterion 5: NbS are based on inclusive, transparent and empowering governance processes**

##### **Indicators**

- 5.1 A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention is initiated
- 5.2 Participation is based on mutual respect and equality, regardless of gender, age or social status, and upholds the right of Indigenous Peoples to Free, Prior and Informed Consent (FPIC)
- 5.3 Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention
- 5.4 Decision-making processes document and respond to the rights and interests of all participating and affected stakeholders
- 5.5 Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision making of the stakeholders in the affected jurisdictions

#### **Criterion 6: NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits**

##### **Indicators**

- 6.1 The potential costs and benefits of associated trade-offs of the NbS intervention are explicitly acknowledged and inform safeguards and any appropriate corrective actions
- 6.2 The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders, are acknowledged and respected
- 6.3 The established safeguards are periodically reviewed to ensure that mutually-agreed trade-off limits are respected and do not destabilise the entire NbS

**Criterion 7: NbS are managed adaptively, based on evidence**

**Indicators**

- 7.1 A NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention
- 7.2 A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle
- 7.3 A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle

**Criterion 8: NbS are sustainable and mainstreamed within an appropriate jurisdictional context**

**Indicators**

- 8.1 The NbS design, implementation and lessons learnt are shared to trigger transformative change
- 8.2 The NbS informs and enhances facilitating policy and regulation frameworks to support its uptake and mainstreaming
- 8.3 Where relevant, the NbS contributes to national and global targets for human well-being, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)

At the end of the publication, as annex of each criterion and indicators, relevant case studies are presented. This can contribute to understanding the aim of the respective criterions and indicators.

In **Anonymous 2020b** links between NBS principles and standards are presented Fig. 3.8.

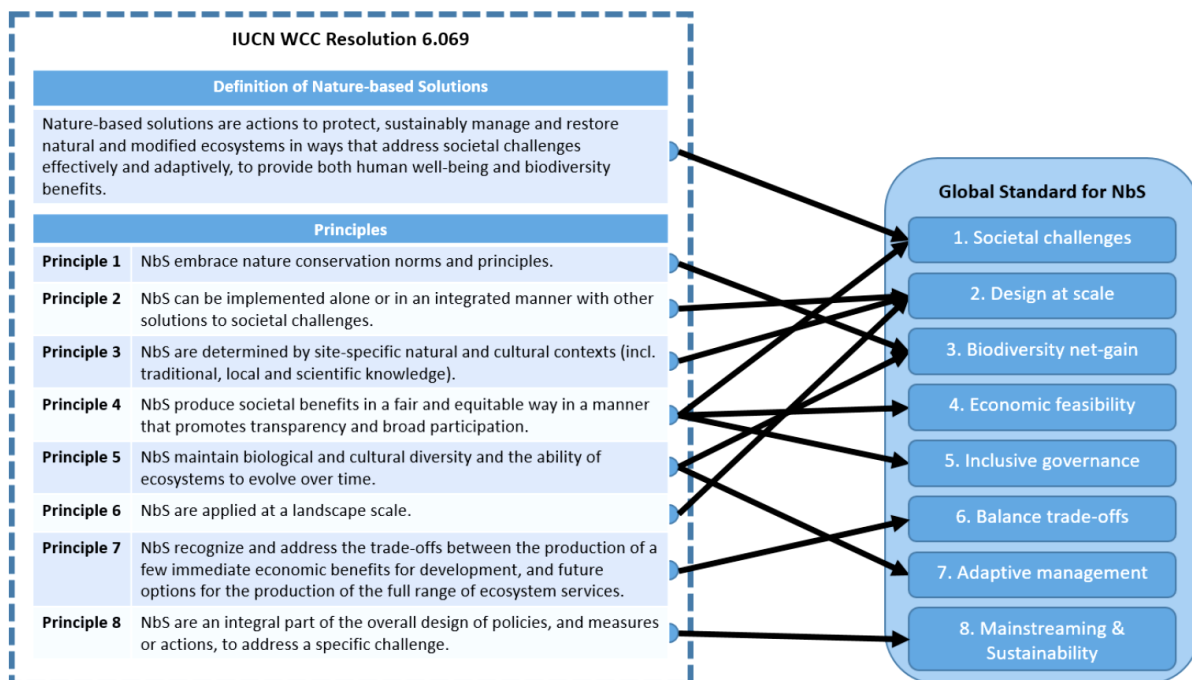


Fig. 3.8 Link between the NbS Principles and the NbS Standard Criteria. (© IUCN)

Conveniently, the principles listed correspond to a high level, with the criterions presented in the previous publication. Additionally a link with Global Standards for NBS is demonstrated. This causes some confusion for the reader and users. What is to be used for assessment? It seems, indicators.

Further, the proposal for self-assessment, very useful for NBS teams, is presented. The evaluation system of *traffic lights* is proposed. Citation:





*“The self-assessment will make use of a traffic light system for indicating the status of the different listed indicators where green expresses that an indicator is fully met, orange illustrates partially reached and red, no accomplishment.”*

And:

*“For each indicator, a score out of four is recorded, depending on whether the intervention addresses the indicator to a strong, adequate, partial or insufficient extent. The result is used to calculate the level of adherence to each individual Criterion, also giving a strong, adequate, partial and insufficient result for scores greater than 75, between 50 and 75, between 25 and 50 and lower than 25 percent respectively.”*

An example is presented in Tab. 3.2.

Tab. 3.2 Output of self-assessment sheet

	Key (%)	Output
	≥75	Strong
	≥50 & <75	Adequate
	≥25 & <50	Partial
	<25	Insufficient
		Intervention does not adhere to the IUCN Global Standard for NbS.

The utilization of Standards is demonstrated in Fig. 3.9.

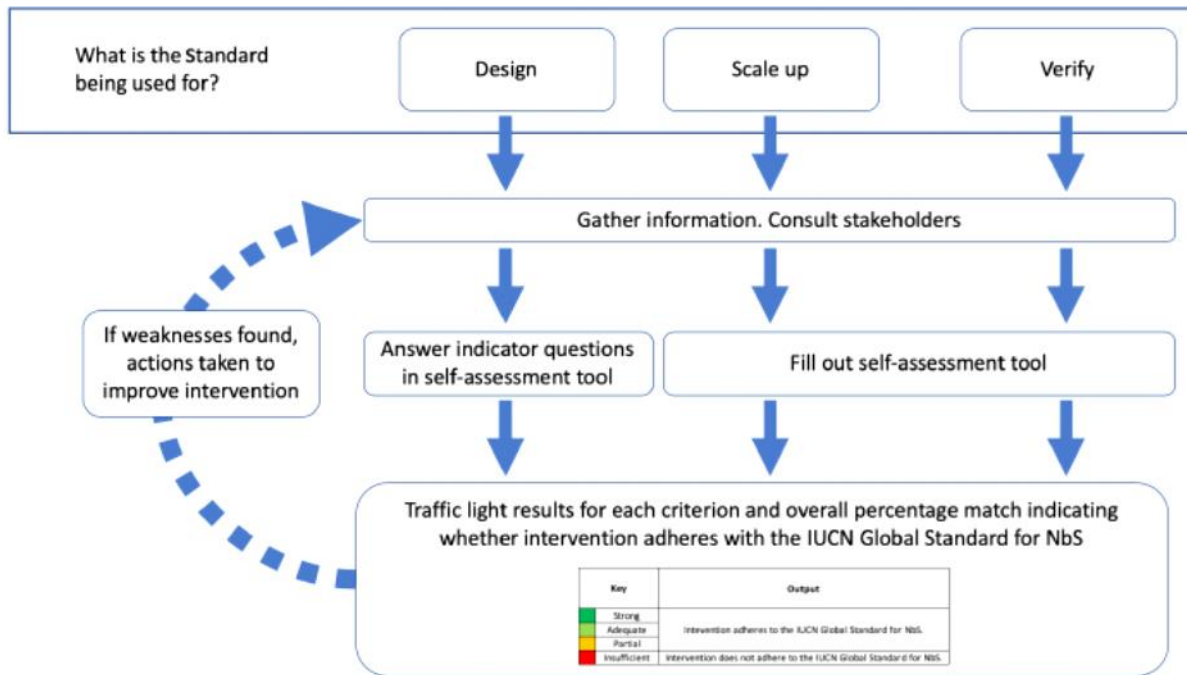


Fig. 3.9 How to use the Standard and how it is linked to the self-assessment. (© IUCN)

In titles of both publications the term “First edition” is written. Obviously, refining and upgrading of methods are planned. At the conclusion of second publication it is mentioned that Part III (Part I and II are here used publications), user-guide, is to be developed in future. Furthermore, the possibility of contacting NbS Group at IUCN for consultancies is offered.

**Comments:** The term *standard* has multiple meanings. This creates some confusion for readers. It would maybe be appropriate to replace it with a more understandable term.

In both publications legal issues are mentioned. This is not a crucial component of NBS project but should be considered and included in the method. In some cases, the ownership of a location or parts of it, could be a barrier for realization of project/intervention.

The second publication contains a voluminous and useful Glossary of definitions.

### 3.2.3 European Commission Sources

Crucial publications relevant for EcoDaLLi methodology are **Dumitru and Wendling** (2021a, 2021b) and **Cardinali et al.** (2021). These are based on 26 projects, financed or co-financed by the EU, that are predominantly related to urban and peri-urban restorations by using the NBS approach. The applied methodology, or, more accurately, approaches, are applicable for almost all other NBS projects/interventions. However, some specific priorities and indicators should be used. All three publications contain examples of projects already realized, that could be a good base for capitalization and fertilization by performing their own methodology. Very important is the data listed that can be used by decision makers and practitioners in realization of their own NBS projects/interventions.

#### **The publication Cardinali et al. (2021)**

This publication is focused on the actions of policy makers, who should have significant role in activities of conceptual solution/s of NBS development (be part of experts working group), or, at least, in evaluation of them.

Further, the main steps and results to be elaborated and evaluated by policy makers are presented.

## **WHICH SOCIETAL CHALLENGES FOR PLANNED NBS ARE ADDRESSED**

(Here are selected those crucial specific for EcoDaLLi case)

**Water Management**

**Biodiversity Enhancement**

**Health and Wellbeing**

**New Economic Opportunities and Green Jobs**

## **ROBUST IMPACT ASSESSMENT OF NATURE-BASED SOLUTIONS**

Impact assessment is related to the NBS planning and evaluation phase. After realization of NBS, monitoring and evaluation of effects are performed. In other publications *robustness* is mostly related to monitoring data plausibility, but also adaptivity of procedure to the eventual disturbances.

## **DEVELOPING A THEORY OF CHANGE**

The term *Theory of Change*, used by many authors, presents target values of the project/intervention, expected to be obtained by performing NBS. It should include:

**Outcomes** The concrete results sought through the implementation of an NBS.

**Outputs** The visible part of nature-based solution interventions necessary to fulfil the outcomes.

**Intended impacts** The effects or changes that are not only desirable but are explicitly targeted through the Nature-based Solution action.

**Unintended impacts** The (usually) negative, unforeseen results of NBS implementation.

**Synergies** Interrelations of positive effects.

**Trade-offs:** Interrelations of "negative effects".

### **The publication Dumitru and Wendling (2021b)**

This publication demonstrated a pragmatic approach intended for practitioners. Same as the previous one, this publication is primarily based on a review of EU financed projects relevant to NBS.

In Fig. 3.10 the cycle of NBS project is presented. It could be reused, but, the titles and contents of activities should be additionally considered and refined.



Fig. 3.10 A schematic diagram showing the full project life cycle of NBS such as monitoring and evaluation, cost benefit analysis (adapted from **Kumar et al.**, 2020)

The major chapters of the publication are presented below:

**PRINCIPLES GUIDING NBS PERFORMANCE AND IMPACT EVALUATION** (chapter 2 in the publication)

Introduction and definitions

Decision-making context and impact evaluations: from needs to indicators

Principles for the development of impact monitoring and evaluation plans

Capitalizing on existing experiences and remaining critical concerns

**APPROACHES TO MONITORING AND EVALUATION STRATEGY DEVELOPMENT** (chapter 3)

Introduction: developing robust impact assessment plans

A step by step approach to developing robust monitoring and evaluation plans for NBS

Robust assessment and co-production: a necessary relationship

**INDICATORS OF NBS PERFORMANCE AND IMPACT** (chapter 4)

For all twelve societal challenges (presented in Fig. 2.5), indicators are listed. For EcoDaLLi the indicators for Water Management and Biodiversity Enhancement are relevant.

In Fig. 3.3 only a general example for Biodiversity Enhancement is presented. In the publication, 27 additional indicators are listed also.

Tab. 3.3 Indicators related to Biodiversity Enhancement classified as structural (S), process focused (P) or outcome-based (O) indicators and their general applicability to different types of NBS

No.	Indicator	Units	Class	Applicability to NBS <sup>†</sup>		
				Type 1	Type 2	Type 3
<b>RECOMMENDED</b>						
9.1 9.1.1	Structural connectivity of urban green and blue spaces	various	O	●		●
9.1 9.1.2	Functional connectivity of urban green and blue spaces	various	O	●	●	●
9.2	Number of native species	Number	O	●	●	●
9.3	Number of non-native species introduced	Number	O	●	●	●
9.3.1	Number of invasive alien species	Number	O	●	●	●
9.4	Species diversity within a defined area	Number	O	●	●	●
9.5	Number of species within a defined area	Number	O	●	●	●

<sup>†</sup>**Type 1 NBS** – minimal or no intervention in ecosystems, with objectives related to maintaining or improving delivery of ecosystem services within and beyond the protected ecosystems

**Type 2 NBS** – extensive or intensive management approaches seeking to develop sustainable, multifunctional ecosystems and landscapes in order to improve delivery of ecosystem services relative to conventional interventions

**Type 3 NBS** – characterised by highly intensive ecosystem management or creation of new ecosystems

For each indicator unit and class (description in the table title) is mentioned, as well as the applicability of NBS type. One citation relevant to this issue:

*“Both the Shannon Diversity Index (9.4) and Shannon Evenness Index (9.5) are recommended indicators of biodiversity. The Shannon Diversity Index is commonly used to evaluate species diversity within a defined area. Whilst the Shannon Diversity Index does not qualify whether the species present are native, non-native or alien invasive, it accounts for the number of different species observed within a given space and their relative abundances. The Shannon Evenness Index provides information about the relative number of individuals of each species in a given area.”*

Structural and functional connectivity are mentioned as well. Definitions are as follows:

- Structural connectivity – relating to the spatial configuration of patches, without considering the movement of individual organisms among these patches (**loja et al. 2014**) and
- Functional connectivity – relating to the ability of organisms to move among patches (**Tischendorf and Fahrig, 2000**).

## **APPLICATION OF THE NBS IMPACT EVALUATION FRAMEWORK: NBS PERFORMANCE AND IMPACT EVALUATION CASE STUDIES** (chapter 5)

In this chapter, case studies from a variety of NBS demonstrations across Europe and Asia are presented that illustrate the application of the NBS indicators and methods presented in Chapter 4. For the EcoDaLLi project **Biodiversity Enhancement – Number of conservation priority species** is a relevant example. Outcomes of the same studies are presented in Chapter 5 of this study.

## **DATA REQUIREMENTS** (chapter 7)

As stated, this extensive chapter, offers an overview of the main types of data, data sources, and data generation techniques for NBS monitoring and impact assessment. Citation:

1. *“Provides knowledge regarding available data sources;*
2. *Assists in developing a robust plan for the collection, management and use of data;*
3. *Offers examples of how data have been collected and integrated by various EU Horizon 2020 projects; and,*
4. *Raises awareness of the challenges commonly encountered such as data gaps, data availability, data reliability and related potential error sources.”*

Proper and plausible data are very important for design and evaluation of NBS. From the very beginning baseline assessment should be performed. Citation:

*“Baseline data collection is essential for any future evaluation of NBS performance. Baseline data should essentially be able to convey both the “state of play” (initial situation, from the social, economic, environmental points of view) as well as temporal and spatial trends of parameters, which will be further monitored and assessed throughout the project implementation and at its conclusion. The assessment is related to the performance evaluation of the NBS itself, and it is not*

aimed for the comparison between the NBS intervention and other grey or hybrid solutions dealing with the same issues. Especially for nature-based solutions, identifying initial trends allows an understanding of how the baseline conditions may change in the absence of the proposed actions, and thus for the definition of “business as usual” scenarios.”

Data is in the development phase and for performing a monitoring and evaluation plan.

Only a few illustrations of this chapter are presented here. NBS developers and performers could find here very useful instructions. In the following figures the most significant methods for data collection, including Living Labs are presented.

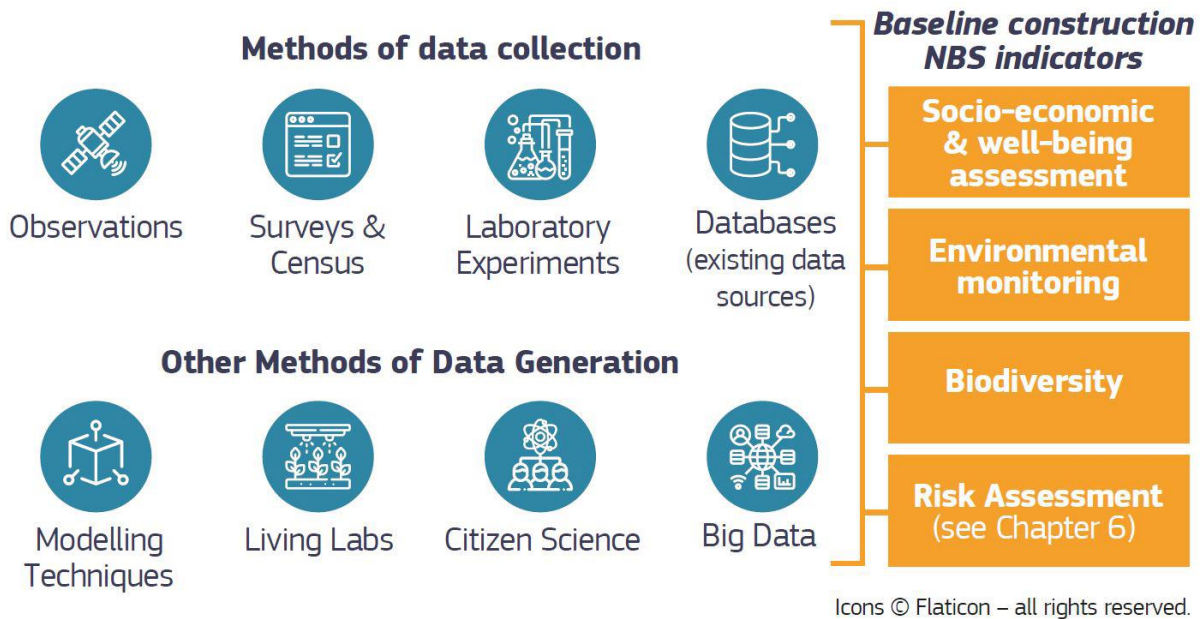


Fig. 3.11 How can we generate data for NBS monitoring and evaluation?

The next figure presents a data collection scheme for biodiversity NBS.

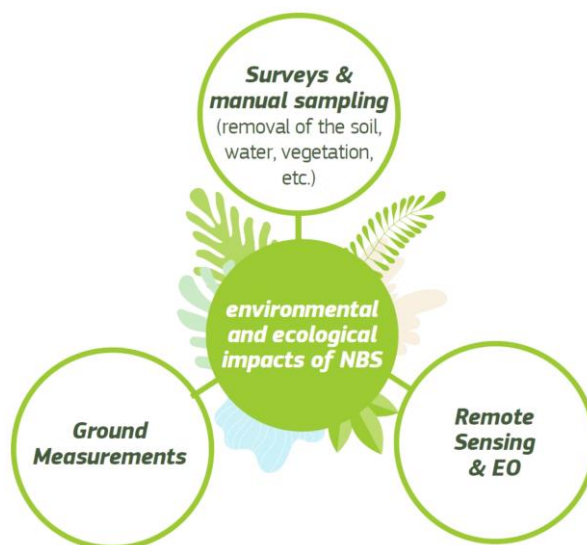


Fig. 3.12 How to generate and collect data to evaluate the environmental and ecological impacts of NBS? (EO Earth Observations)

In Tab. 3.4 a case-example of a monitoring protocol for pollinators biodiversity, developed within an EU financed project, is presented.

Tab. 3.4 Examples of biodiversity monitoring protocols (based on the monitoring activities conducted in the EU-H2020 project proGReg). Source: **Baldacchini (2019)**

Category	Monitoring Protocols Adopted
<p><b>Pollinator biodiversity monitoring</b></p> <p>Pollinators play a key role in every terrestrial ecosystem. They are pivotal not only from a biodiversity conservation point of view, but also for food production and for global economy. Monitoring this insect group is very useful to evaluate the environmental status (EU Pollinators Initiative 2017, Underwood 2017).</p>	<p><i>Site: Urban park (Turin, Italy).</i></p> <p><b>Data sampling is conducted along specific transects, which allows the recording of associations between flowers and pollinators.</b> Transect walks also offer the possibility to evaluate the success of NBS implemented by combining butterfly and bee responses at community level. Surveys are made from April to September. Windy and rainy days are avoided for all observations and samplings.</p> <p><b>Bee surveys:</b> Each survey comprises 250m long linear transects walked in 50 min. Each transect start point and direction walked were randomly determined. All bees unambiguously identifiable are recorded and all others are caught for later identification. Bee richness and abundance are determined. The honeybee is identified to species level (<i>Apis mellifera</i>) while other bees are identified to genus level. Surveys are made at least one per month, between 9:00 am and 5:00 pm.</p> <p><b>Flower surveys:</b> Larval food plants and adult nectar sources of butterflies as well as flower surveys are carried out in parallel to the bee and butterfly surveys along the transects.</p> <p><b>Butterfly surveys:</b> Transects are 300-500 m long, depending on the investigated area (according to the "Pollard walk" (Pollard and Yates 1993). Butterfly species are identified, and individuals of each species counted. Surveys are made, every two weeks, between 10:00 am and 3:00 pm for butterflies.</p>

In this chapter, issues relevant to the acquisition and monitoring of data developed in a frame of many EU financed projects, are presented.

**The publication Dumitru and Wendling (2021a)**

This voluminous publication is a compilation of methods for the determination of indicators of NBS performance and impact. Experts in a wide variety of disciplines from eighteen (eighteen is written, seventeen presented in list, p. 18) EU H2020 NBS projects and a number of supporting European programs were directly involved in the production of this valuable publication.

In this publication convenient procedures for using elements of NBS described in previous publications, such as indicators, data use, procedures for project assessment, monitoring and evaluation, are developed. Although the publication is primarily oriented toward urban area restoration, the presented approach, methodology and methods can be used for other NBS.

In the next table the application of the procedure for biodiversity is demonstrated.

Tab. 3.5 Number of native species, project name: CONNECTING Nature (Grant Agreement no. 730222)

Number of native animal species	Biodiversity
<b>Description and justification</b>	The total number of native species within a defined area (site/neighborhoods/region/city). This can comprise one or more of the following taxonomic groups (it should be specified which groups are covered): a. Plants b. Birds c. Butterflies d. Invertebrates e. Mammals
<b>Definition</b>	Provides an overview of the species diversity, with distinctions able to be made across taxonomic groups if multiple groups can be covered. Defined species can also serve as an indirect “indicator” for the habitat quality.
<b>Strengths and weaknesses</b>	Results can support the evaluation of the original aims of a nature-based solution scheme and can monitor performance against these aims over time. Classification of native can be complicated by naturalised species and there is much debate over the role of non-native species in conservation biology, particularly in urban areas.
<b>Measurement Procedure and tool</b>	The sum for each taxonomic group is calculated using field survey. It should be clarified whether this is the exact number or an estimation.
<b>Scale of measurement</b>	Number of species in a defined area
<b>Required data</b>	Survey data
<b>Data input type</b>	Quantitative
<b>Data collection frequency</b>	Typically annual, but can be less frequent if resources are stretched.
<b>Level of expertise required</b>	High expertise is typically required for species identification. This requirement can be reduced if an index of easily identifiable species is created as a proxy.
<b>Synergies with other indicators</b>	Synergies with non-native and invasive species indicators.
<b>Connection with SDGs</b>	SDGs 14, 15.
<b>Opportunities for participatory data collection</b>	Surveying represents an excellent opportunity for widening participation.

**Comments:** These three EC publications provide fundamental support for the creation of the methodology, especially useful indicators. It is however missing a presentation of activities over the whole lifespan of NBS.

However, challenges, indicators, data, and other specific elements of NBS should be defined for diverse projects/interventions.

Publications with a lot of instructions and examples could be used as guidelines relevant to NBS.

### 3.2.4 Other relevant sources

In this subchapter other ideas and approaches relevant to NBS methodology are presented, which might be of interest for the development of the EcoDaLLi methodology.

On their website, the institution **Nature-Based Solutions Community** ([www.nature-basedsolutions.com](http://www.nature-basedsolutions.com)) proposed the following steps for NBS realization:

#### **Step 1: Understand the system**

Before defining a solution, the full context of the system must be understood. This involves acquiring in-depth knowledge of the bio-physical, socio-economic, and governmental aspects of the system. Understanding these separate aspects leads to a win-win solution.

#### **Step 2: Link values to your system**

Identify which functions and services the system has and can provide and recognise how these functions are valued. Distinguish realistic alternatives that lead to not only mitigation and compensation of issues, but also to safeguarding and sustainability of the system moving into the future.

#### **Step 3: Develop the solution**

Develop the solution towards its realization. This step includes design details, project delivery, monitoring, adaptation and maintenance.

**Comment:** This is very simplified approach, but logical. Could be used as inspiration for own development of NBS project life cycle methodology. However, steps could be renamed, and description of them deeper and more adequately explained.

In the publication **Dushkova and Haase** (2020) methodology for data and knowledge database of NBS projects is elaborated. This was developed within, the earlier mentioned EU CONNECTING Nature project (COproductionN with NaturE for City Transitioning, INnovation and Governance).

It is mentioned that data and knowledge bases lead to an overall improvement in data quality. The rise in user numbers increases the frequency of the detection and correction of problems in the data. These databases are cost-effective and allow the saving/storing of important information in a categorized form.

In the following figure the model illustrating the scope of activities that took place during the data and knowledge base creation, development and implementation process is presented.

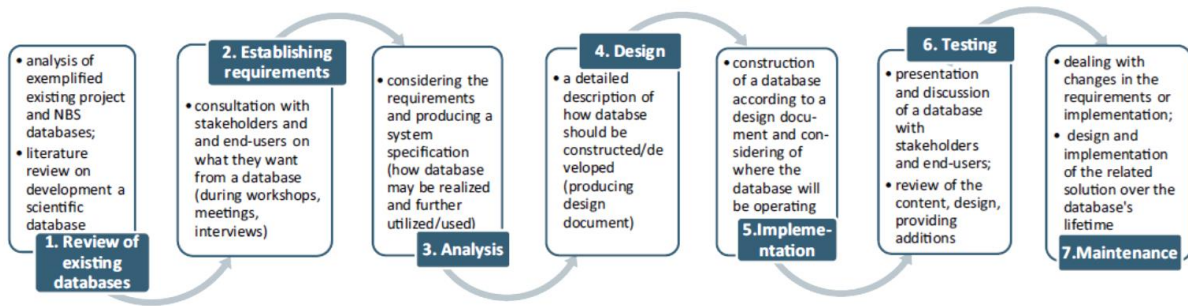


Fig. 3.13 Overview of the NBS data and knowledge bases development during life cycle

The collection of these seven steps is referred as the so-called NBS database life cycle. Each phase in the life cycle can be checked for correctness before moving on to the next phase.

The data in these databases is divided into four parts, Fig. 3.14, of which II. and III. are significant for this publication.

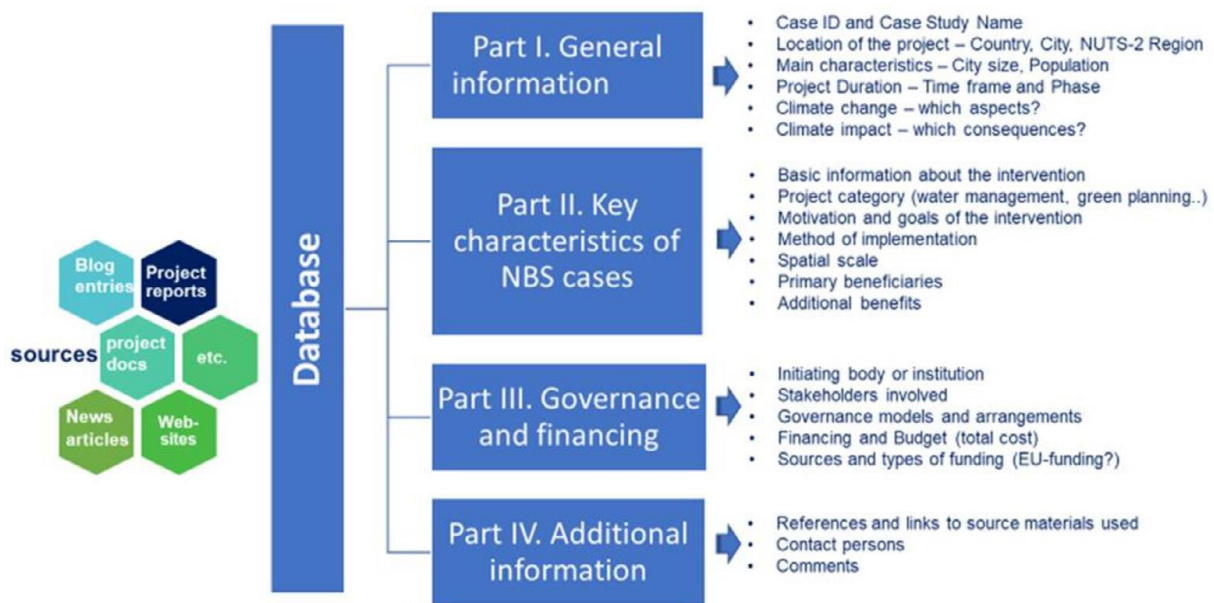


Fig. 3.14 Information sections presented in the CONNECTING Nature data and knowledge base

**Comment:** Creation of bases on contemporary pertinent data and knowledge, especially related to good practice, has the great importance for development of own NBS cases.

In **Ruangpan et al. (2020)** results of a flood (hydro-meteorological) risk reduction by incorporating stakeholders’ preferences in performing Nature-based Solution on two small rivers, both in steep areas, Tamnava in Serbia and Nangang in Taiwan are presented. Tamnava is a tributary of Kolubara, which is a tributary of river Sava, i.e. Danube River Basin.

The project is realized in the frame of EU project RECONNECT- Regenerating ECOsystems with Nature-based solutions for hydro-meteorological risk rEduCTion ([www.reconnect.eu](http://www.reconnect.eu)).

The authors established an interesting connection of NBS and other similar, previously introduced, solutions-approaches, and terms:

*“...Low Impact Developments (LIDs), Best Management Practices (BMPs), Water Sensitive Urban Design (WSUD), Sustainable Urban Drainage Systems (SuDS), Green Infrastructure (GI), Blue-Green Infrastructure (BGI), Ecosystem-based Adaptation (EbA) and Ecosystem-based Disaster Risk Reduction (Eco-DRR).”*

This is followed by statement, conclusion, expressing temporary phase of NBS:

*“No single NBS can solve all problems and NBSs are not yet easy to implement in practice. The most suitable solution will depend on local necessities and characteristics. To improve acceptance and implementation of NBSs, decision support tools can be used by considering multiple stakeholders’ views, trade-offs and feasible measures (De Brito and Evers, 2016). A flexible decision tool capable of integrating multiple objectives is thus required.”*

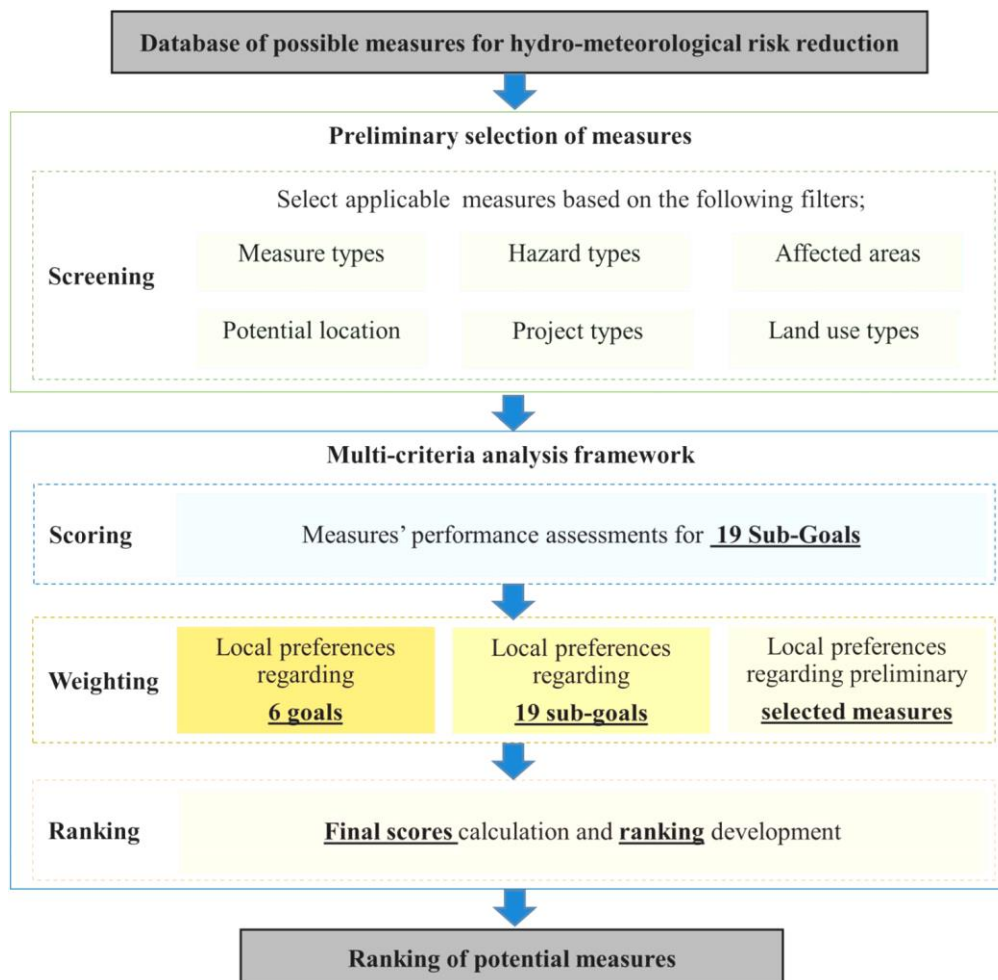


Fig. 3.15 Proposed methodology for selecting potential NBS measures, including preliminary selection and Multi-criteria analysis MCA framework

The improvement consists of the inclusion of different types of hazards and scales (i.e. river basin, coastal zone or urban area) into the analysis. The methodology includes a wide range of possible NBS benefits (reduction of hydro-meteorological risks, improvement of water quantity, protection and enhancement of habitats, safeguarding of biodiversity and socio-

economic and human wellbeing). By including these criteria into MCA, the methodology results in a different ranking of the measures compared to the traditional ranking based on risk reduction alone.

Results obtained for relevant NBS are presented in Fig. 3.16. For the evaluation MCA, and methodology presented is used.

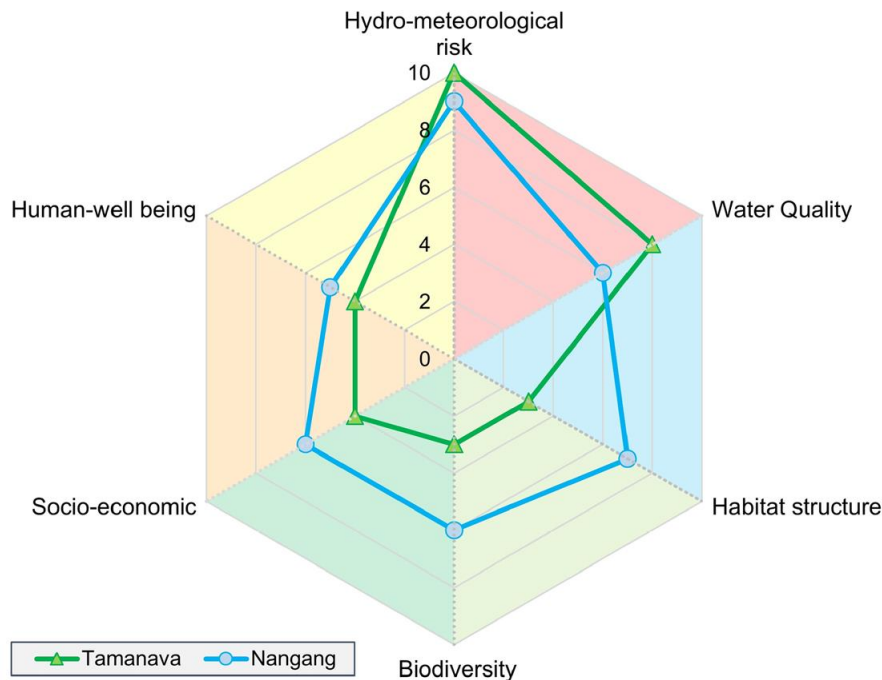


Fig. 3.16 Weighting results of Tamnava and Nangang case studies, relative importance of evaluating main goals

Finally, the following conclusions related to including stakeholders are proposed:

*“Involving stakeholders in the process of measure selection in an MCA can introduce additional relevant aspects that might be unnoticed by engineers. Lastly, the methodology enables decision-makers to identify the most suitable and preferable NBS measures for the area, which can help obtain more realistic results in relation to suitability of measures to the case studies.”*

**Comments:** Highlighted importance of engagement of local stakeholders in the selection of relevant aspects for NBS solutions.

Demonstrated applicability of Multi-criteria analysis -MCA.

In the publication **Sarabi et al.** (2022) one of the results of the EU financed project UNALAB (<https://unalab.eu>), urban restoration for Eindhoven is presented. The so-called Nature-Based Solutions Planning Support System (NBS-PSS) was introduced. This system is aimed to enable the following (citation):

- a) *“providing a multiscale environment to facilitate communication and collaboration across scales which is necessary for strategic NBS planning (Demuzere et al., 2014; Wyborn & Bixler, 2013);*

- b) providing a flexible framework that can be adopted by cities with different goals, and with access to different types of data;
- c) providing the required flexibility and transparency for NBS planning by integrating the procedural and rule-based knowledge which is necessary for proposing effective solutions to complex problems (**Leung, Fischer, & Nijkamp, 1993**); This enables users to include their local knowledge in the analysis;
- d) providing an integrated framework for the prioritization of NBS measures and assessment of site suitability;
- e) maximizing the NBS benefits and co-benefits through integrating different functionalities while considering the practicality of solutions.”

The applied NBS-PSS is schematically presented in Fig. 3.17.

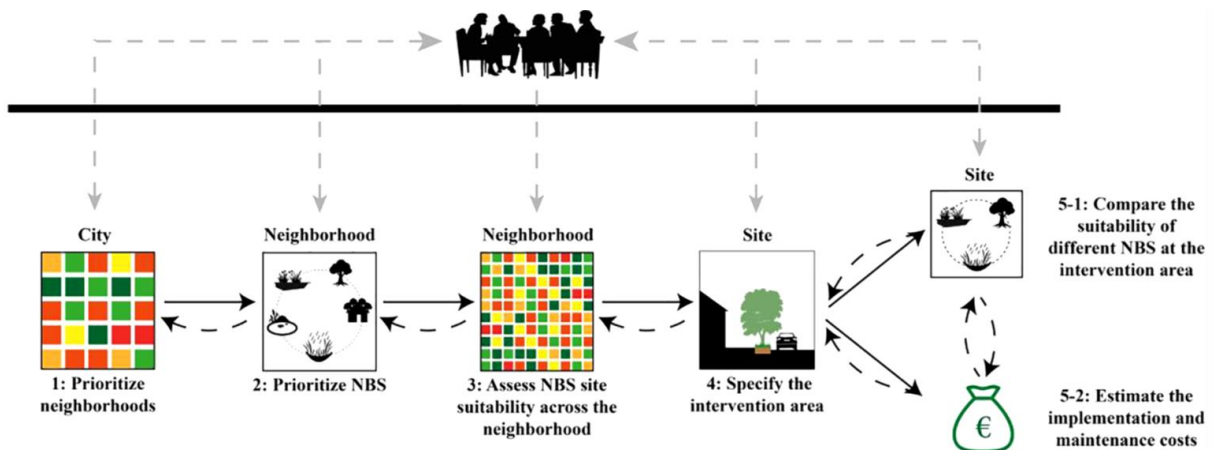


Fig. 3.17 NBS-PSS process flow (continuous black lines show the forward movement between different steps and black dashed lines refer to iterations among steps; the grey dashed lines point at opportunities for interaction between users and the NBS-PSS)

Besides the advantages of NBS-PPS, some limitations are mentioned, e.g. lower robustness in comparison with other analyses. One possibility to omit limitations is notified (citation):

*“Important improvement of the current version of the NBS-PSS can be to account for the synergies and trade-offs between the various ecosystem services. Different ecosystem services affect each other, but not always in a positive way (**Haase, Schwarz, Strohbach, Kroll Seppelt, 2012**). In this & respect, understanding the synergies and trade-offs is essential for developing realistic and effective plans. Finally, future work can provide an estimation of the impact of the chosen NBS at the selected location; this can further help stakeholders to compare different solutions...”*

The publication **Rödl and Arlati** (2022) presented a result of the EU project CLEVER Cities (<https://clevercities.eu>) funded by EU. *“In this is presented an easy-to-use, and structured procedure to support selecting appropriate criteria and indicators for assessing NbS projects. The procedure is designed to be adaptable to any type of NbS project...”*

In Fig. 3.18 assessments needed for the development of projects/interventions having NBS structure are presented. In Fig. 3.19 an approach for assessment of criteria and indicators is schematically described. These could be used for development of the methodology structure.

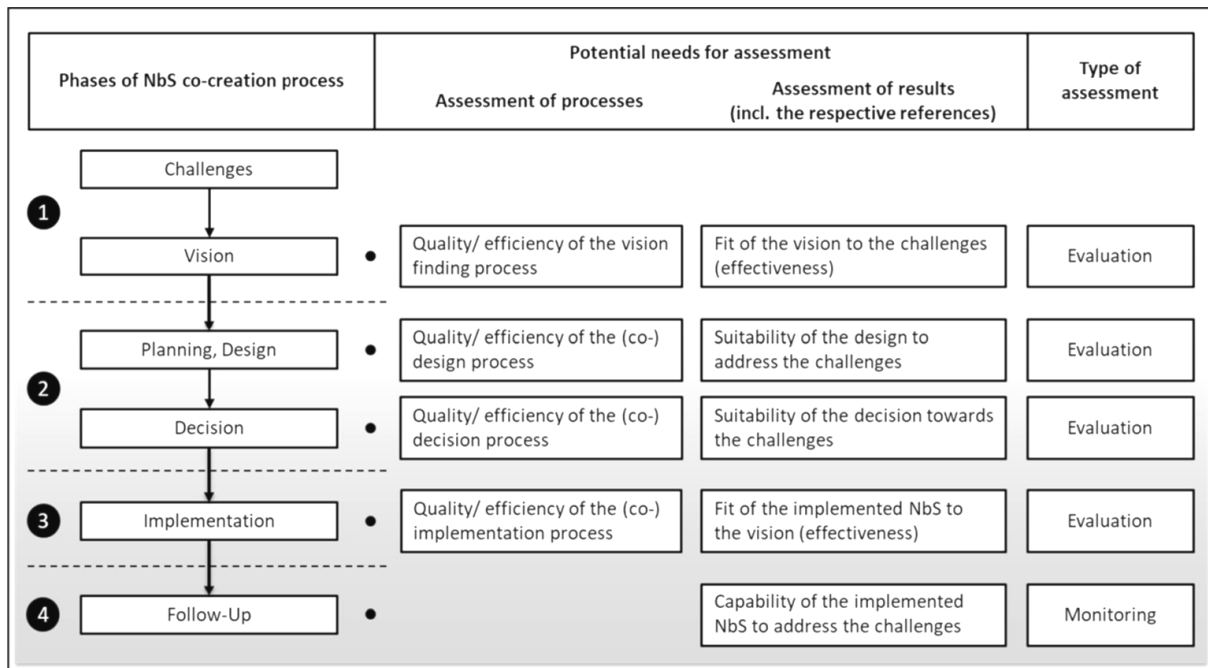


Fig. 3.18 Potential assessment needs in the different phases of NbS co-creation processes (own figure of authors)

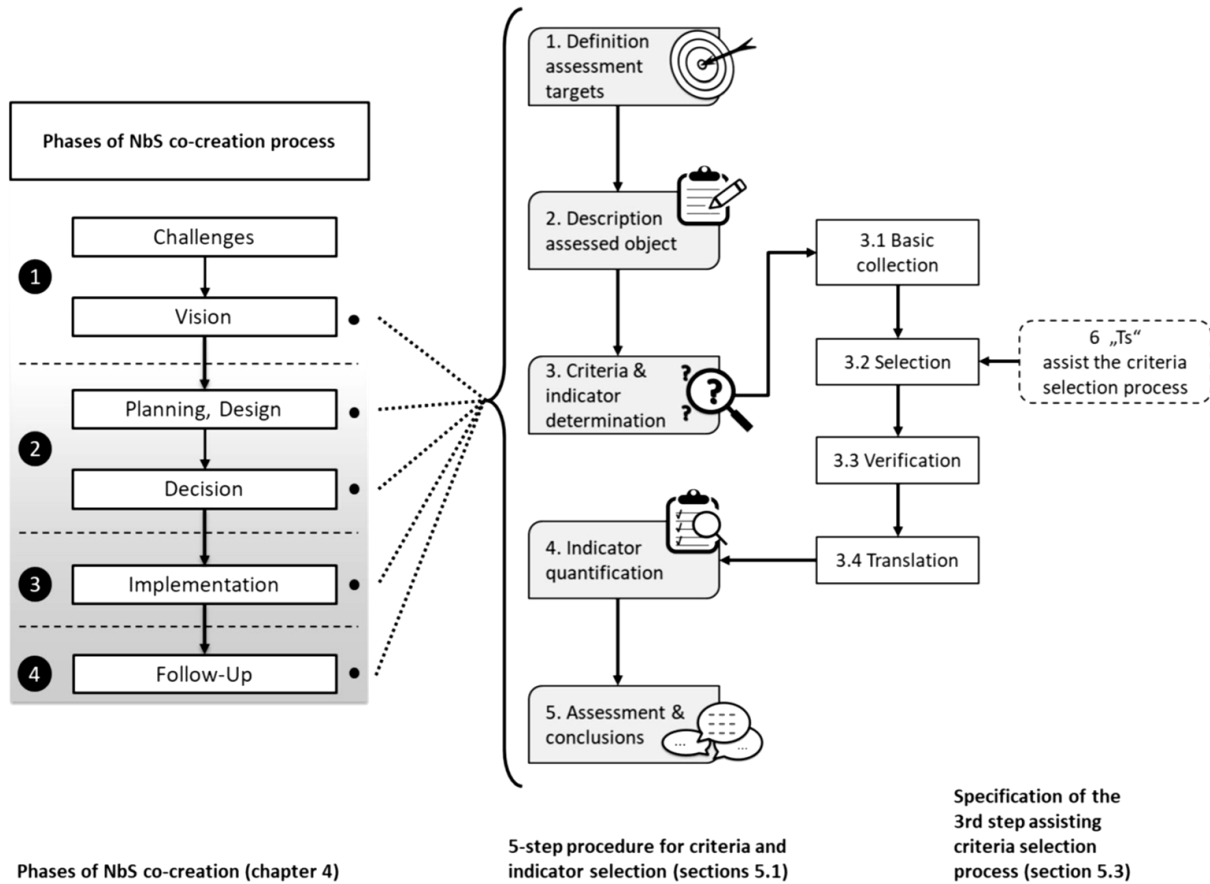


Fig. 3.19 Overview of the entire criteria and indicator selection approach described in this section (own figure of authors)

In **Kabish et al. (2017)**, among other useful content, the type of infrastructure is discussed. From an engineering point of view it could be green, blue and grey. Green infrastructure is based on vegetation, blue on water and grey is traditional infrastructure, based on concrete and similar materials. There are also hybrid infrastructures, combination of all three. In chapter 6 the following is written (citation):

*“This chapter explores the role of grey, green, and blue infrastructure and in particular hybrid approaches for disaster risk reduction and climate change adaptation to shed light on available sustainable adaptation opportunities in cities and urban areas. We highlight the dependence of cities on ecosystems as a key component of climate resilience building through case studies and literature review. At the same time, we highlight the limitation and drawbacks in the adoption of merely grey or merely green infrastructures. We suggest that an intermediate ‘hybrid’ approach, which combines both blue, green and grey approaches, may be the most effective strategy for reducing risk to hazards in the urban context.”*

By using NBS, grey should be eliminated or reduced to a minimal possible extent. However, this is sometimes difficult. The problem of reduction or elimination of grey infrastructures has been discussed in many references. Besides the problem of functionality, there is also the question of costs. It is still not clear whether one grey infrastructure, that deals very efficiently with many challenges, e.g. biodiversity (fish passes), can be validated as NBS. Or, which is, for the validation, the highest share of grey in one hybrid solution? This is illustrated in the following comment from **World Bank (2017)**:

*“Working with natural processes and green solutions both represent nature based flood risk management solutions. Green-gray solutions refer to hybrid solutions that combine traditional infrastructure such as dikes with ecosystem restoration or other natural solutions. Only if there is no other option available, traditional (gray) solutions can be selected.”*

In the same publication, the problem of costs is discussed. In many cases, e.g. flood protection, grey solutions costs are considerably lower.

### List of other reviewed sources relevant for methodology

No	Reference	Comments
1	Kabisch et al. (2016)	Described procedure for selection of NBS effectiveness indicators as well as knowledge gaps.
2	Dumitru and Lourido (2022)	Simplified guidebook, distinguished outcome and primary indicators and participatory planning and governance indicators.
3	Seddon et al. (2020)	Integrating NBS to climate change impacts into the social–ecological vulnerability framework.
4	Wild et al. (2020)	Extensive survey of EU NBS related projects.
5	Anonymous (2014)	Described modern grey infrastructures for water management much efficient than green ones.

### COMMENTS

This chapter reviews knowledge related to NBS methodology that can be utilized by project developers, practitioners, and for desk analyses. One of the most significant and informative documents is authored by Dumitru and Wendling (2021b). The information provided in this chapter can help reduce both working time and costs associated with project development, serving as a valuable contribution to this deliverable. In many cases, especially for smaller projects, the development can be achieved solely by utilizing this deliverable or with limited engagement from experts (outsourcing), leading to clear reductions in both costs and working time.

However, examples of a simple and easily understandable methodology for the comprehensive development of complete NBS projects, particularly for ecosystem restoration in the Danube Basin, are lacking.

Chapter 3.1 presents comments and remarks from the authors, highlighting the most significant issue: the insufficient consideration of legal aspects related to land and water body ownership.

Additionally, the reviewed publications do not adequately emphasize the importance of applying and/or developing innovative solutions. This emphasis is central to the developed methodology. The methodological approaches and frameworks presented in the reviewed publications primarily focus on large-scale NBS projects, while the methodology developed here is also applicable to small and mini-scale projects.

## REFERENCES for this chapter

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## 4. COMPONENTS OF NBS

Components, criteria or aspects of NBS are presented in chapters 2 and 3. In this chapter aspects relevant to EcoDaLLi's planned methodology are selected. The last subchapter presents the status, challenges, and tasks relevant to the Danube River Basin, based on the publication's survey.

### 4.1 SOCIETAL CHALLENGES AND BENEFITS

Social is an adjective that means 'pertaining to society or its organization' or 'needing companionship and therefore best suited to living in communities'. Societal, on the other hand, is an adjective that means 'relating to society or social relations'.

Here the term societal is used, following the title of chapter 4.1 in the publication **Dumitru and Wendling** (2021b). In this document the term challenge areas for Societal Benefits is introduced. These are, related to urban restoration, as follows:

1. Climate Resilience
2. Water Management
3. Natural and Climate Hazards
4. Green Space Management
5. Biodiversity Enhancement
6. Air Quality
7. Place Regeneration
8. Knowledge and Social Capacity Building for Sustainable Urban Transformation
9. Participatory Planning and Governance
10. Social Justice and Social Cohesion
11. Health and Wellbeing
12. New Economic Opportunities and Green Jobs

Of primary relevance for the EcoDaLLi project are 2, 5, 9, 11 and 12. Secondly, for DRB urban areas, areas 4 and 7 are of interest as well.

In chapter 3.2.1, ten areas related to climate resilience in urban areas are proposed, and those relevant for project EcoDaLLi are highlighted. There is Biodiversity Enhancement merged with Green Space Management. The mentioned **Coastal Resilience**, number 3, could be of interest to EcoDaLLi as well.

In the same publication (**Dumitru and Wendling**, 2021b), twelve areas are presented/listed into three groups, pillars: people, planet and prosperity, Fig. 4.1. This is an interesting schematic presentation.

For particular projects/interventions, other areas could be added, specific to the selected case, however they must be in the line with NBS feature. One example is **Water Quality**, which obviously is in connection with or has an impact on Biodiversity Enhancement. In some cases, like EcoDaLLi, **Connectivity** can be included as a support measure for biodiversity.

The selection and justification of challenging areas are important for validation of the selected project/intervention as NBS.

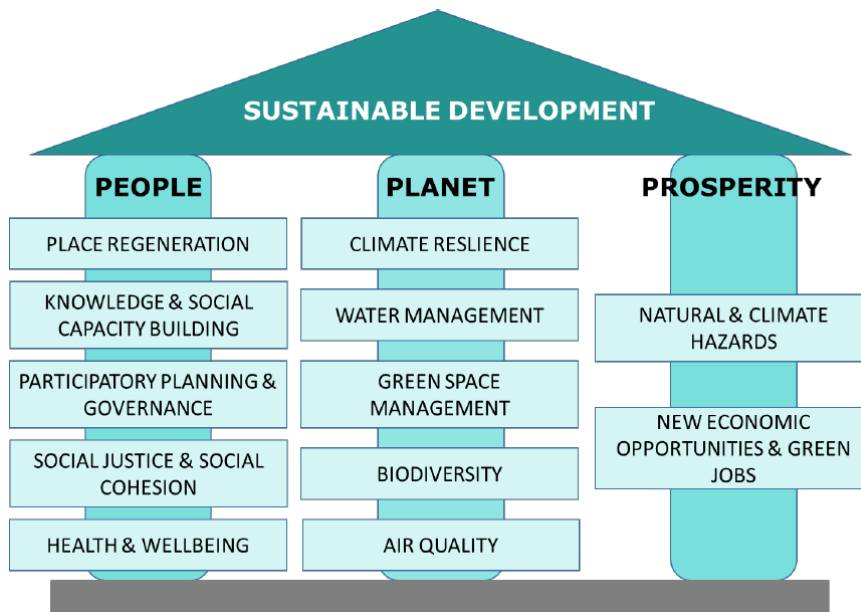


Fig. 4.1 Conceptual mapping of societal challenge areas that can be addressed by NBS onto the triad of People, Planet, Prosperity pillars of sustainable development, **Dumitru and Wendling (2021b)**

Keywords for project task T2.1 are:

1. Biodiversity enhancement, general
2. Free-flowing rivers, Danube and tributaries
3. Connection to all surface water bodies and wetlands
4. Connectivity of vegetation habitats
5. Connectivity of urban habitats
6. Green and blue structure priorities, minimizing hybrid ones.

## 4.2 BIODIVERSITY ENHANCEMENT

The following EU documents are relevant for biodiversity enhancement:

1. Annexes to the proposal for a Regulation of the European Parliament and of the Council on nature restoration. European Commission, **Anonymous (2022)**.
2. EU Biodiversity Strategy for 2030 Bringing nature back into our lives, **Anonymous (2020a)**.
3. Annex EU Biodiversity Strategy for 2030 Bringing nature back into our lives, **Anonymous (2020b)**.
4. Directive 2009/147/EC on the conservation of wild birds, **Anonymous (2009)**.

5. Directive 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life, **Anonymous** (2006).
6. **Anonymous**. 2014. European Commission, Directorate-General for Environment, The EU Water Framework Directive. Publications Office.
7. Regulation (EU) on the prevention and management of the introduction and spread of invasive alien species, **Anonymous** (2014b).
8. Directive 92 / 43 / EEC on the conservation of natural habitats and of wild fauna and flora, **Anonymous** (1992).

Biodiversity is related to all living organisms, fauna, flora and microorganisms. In the publication **Dumitru and Wendling** (2021b) the conductive definition of this issue is presented:

*“**Biodiversity Enhancement:** Biodiversity loss and ecosystem collapse are among the greatest threats society faces in the near term. There are five primary direct drivers of biodiversity loss: changes in land and sea use, overexploitation, climate change, pollution, and invasive alien species. The link between climate change and biodiversity loss involves a feedback loop whereby climate change accelerates loss of natural capital, which is in turn a key driver of climate change. NBS support the EU Biodiversity Strategy for 2030 through the purposeful establishment of protected areas and restoration of degraded ecosystems.”*

One of the oldest pertinent documents related to biodiversity is the **Bonn Convention** (1979). In Article I it is written:

- a) *“**Migratory species**” means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries;*
- b) *“Conservation status of a migratory species” means the sum of the influences acting on the migratory species that may affect its long-term distribution and abundance; etc.”*

This is, in the case of the Danube River Basin, dominantly related to endangered, medium and long-distance migratory, fish species. A typical medium migratory species is the Danube salmon. An example of a long distance species is the sturgeon, which is on the brink of extinction (**DANUBEPARKS**, 2019, **Guti**, 2021). Their biggest problem is the crossing Iron Gates, as in this example presented by **Masliah-Gilkarov** (2021).

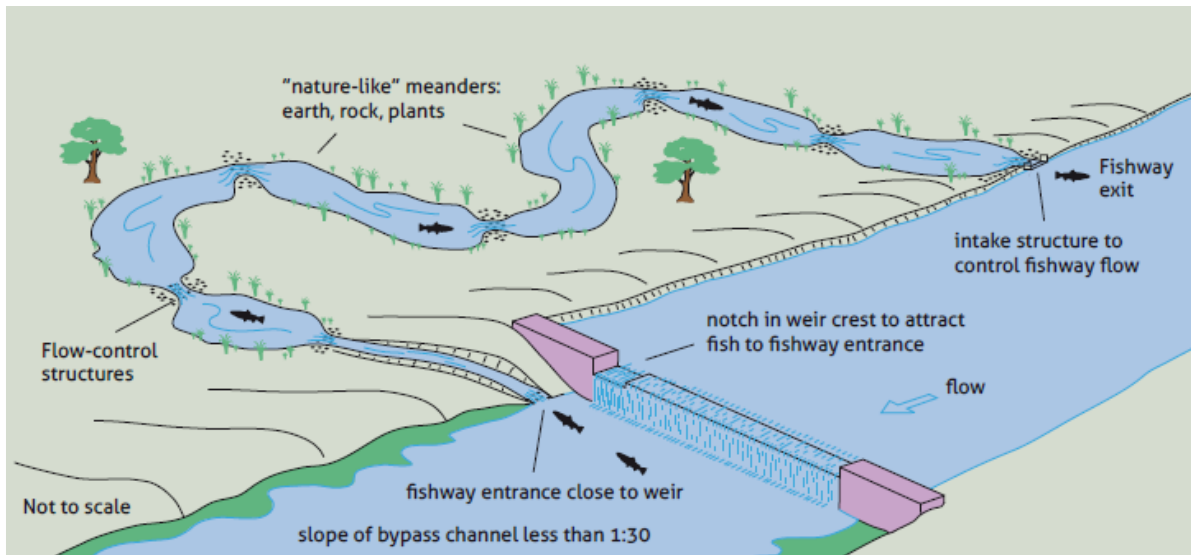


Fig. 4.2 Conceptual layout of a bypass fish way, Gutí (2021)

Some bird species are endangered as well. The Danube Delta is the last refuge in continental Europe for the white-tailed eagle and white pelicans (**Anonymous, 2014c**).

In **Anonymous** (2020a) it is written (relevant for EcoDaLLi and NBS):

*“The EU’s legal framework on water is ambitious but implementation is lagging behind and enforcement must be stepped up. Greater efforts are needed to **restore freshwater ecosystems and the natural functions of rivers** in order to achieve the objectives of the Water Framework Directive. This can be done by removing or adjusting barriers that prevent the passage of migrating fish and improving the flow of water and sediments. To help make this a reality, **at least 25,000 km of rivers will be restored into free-flowing rivers by 2030** through the removal of primarily obsolete barriers and the restoration of floodplains and wetlands. Technical guidance and support to the Member States to identify sites and help mobilise funding will be provided by the Commission in 2021, in consultation with all relevant authorities. Member State authorities should review water abstraction and impoundment permits to implement ecological flows in order to achieve good status or potential of all surface waters and good status of all groundwater by 2027 at the latest, as required by the Water Framework Directive.”*

In the same document the EU Nature Restoration Plan with 14 key commitments by 2030 is presented. Here the commitments relevant to the EcoDaLLi project are listed:

*“9. There is a 50 % reduction in the number of Red List species threatened by invasive alien species.*

*13. The negative impacts on sensitive species and habitats, including on the seabed through fishing and extraction activities, are substantially reduced to achieve good environmental status.”*

The problem of invasive alien species is defined in EU Regulation, **Anonymous** (2014b). The connectivity of habitats is of essential importance for biodiversity enhancement.

This can be structural and functional, as described in chapter 3.2.3. The following paragraph dealing with connectivity is included in the recent publication **Alao Chanou et al.** (2023) (citation):

*“Although today, there is no agreed-upon definition for free-flowing rivers, there is consensus on minimizing barriers to allow the rivers to flow freely. In the guidance document on barrier removal (**European Commission, 2022**) for rivers it is proposed to define a free-flowing river as one that supports connectivity of water, sediment, nutrients, matter and organisms within the river system and with surrounding landscapes, in all of the following four dimensions:*

- a. longitudinal (connectivity between up- and downstream);*
- b. lateral (connectivity to floodplain and riparian areas);*
- c. vertical (connectivity to groundwater and atmosphere);* and
- d. temporal (connectivity based on seasonality of fluxes).”*

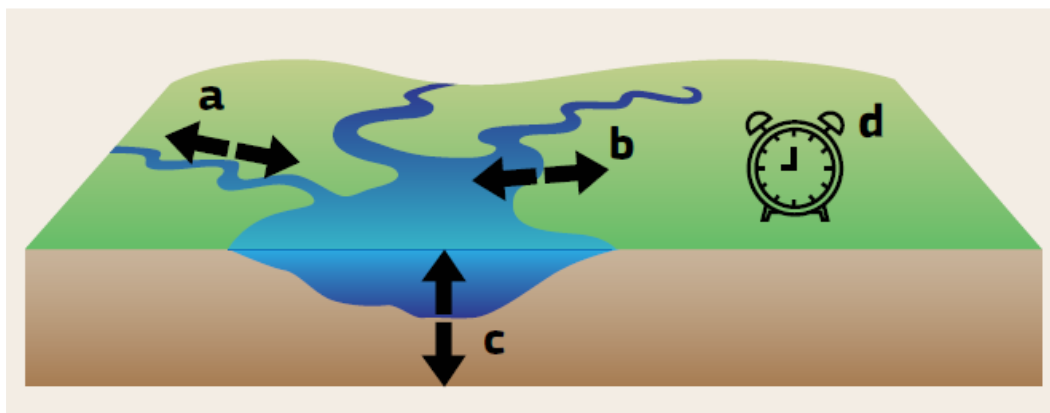


Fig. 4.3 Presentation of connectivity

For the fishes free-flowing rivers are of crucial importance, but, for other fauna and flora riparian vegetation and their connectivity is important. A relevant example close to the objectives of EcoDaLLi T2.1, is defined in **DANUBE PARKS** (2019):

*“Riparian forest habitats are an essential component of the river ecosystem. However, about 90 % of the forests have been lost in the last century due to human intervention. DANUBE parks CONNECTED aimed to restore riparian forests by detecting gaps in the riparian forest corridor for conservation or restoration measures. Such activities might significantly mitigate climate change by increasing the carbon storage capacity of the Danube riparian zones.”*

There are other issues relevant to biodiversity that should be considered as well: conservation of native species, quality of rivers and other bodies of water, impact of agriculture (an example is control of application of pesticides in agriculture, **Tostado and Bollmohr, 2022**) etc. In the publication **Freyhof and Brooks** (2011) the impact of diverse aspects on threatened and non-threatened (Red List) fishes is presented, Fig. 4.4.

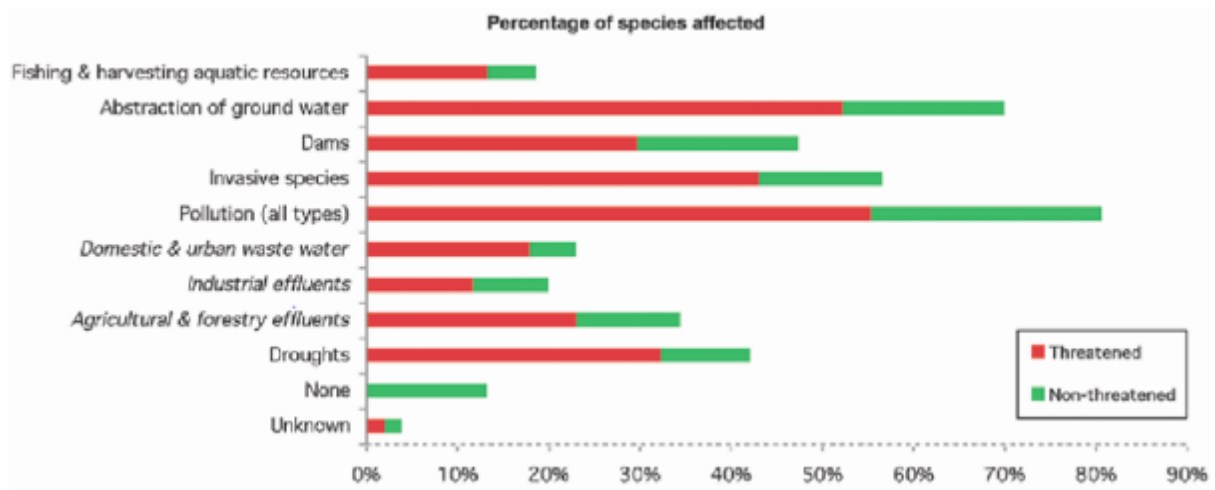


Fig. 4.4 Major threats to freshwater fishes in Europe

Obviously, both categories are highly affected by water pollution. This is why water body's quality should maybe be treated as a separate challenge area. Tid(y)Up Danube Transnational Programme project, **Molnar and Hanko** (2022), has recently been focused on contamination by plastic and micro plastic. The adequate indicators for this type of pollution are still not defined.

### 4.3 PARTICIPATORY PLANNING AND GOVERNANCE

The strategy of stakeholders' engagement should aim to promote inclusive, equitable and even reciprocal relationships for the benefit of both, the organizations investing in NbS, and the stakeholders and communities who have a role to play or are impacted by such projects.

The identified principles and best practices include engaging a diverse range of stakeholders; building long-term relationships and trust; communicating with empathy; prioritizing transparency and accountability; co-creating rather than imposing; recognizing mutual benefits; removing barriers to engagement; formalizing relationships; ensuring adequate financial support; and appointing well-trained, knowledgeable facilitators.

The overall intention is to facilitate **co-design, co-development**, and/or **co-ownership** of NBS projects, and thus increase inclusivity and equity in NbS.

In **Gregg et al.** (2022) the authors are recommending the following Principles and Best Practices:

1. Engage a diverse range of stakeholders
2. Build long-term relationships and trust
3. Communicate with empathy
4. Prioritize transparency and accountability
5. Co-create rather than impose
6. Recognize mutual benefits

7. Remove barriers to engagement
8. Formalize relationships
9. Ensure adequate financial support
10. Appoint well-trained, knowledgeable facilitators

In the same publication engagement of stakeholders within five stages is proposed, Fig. 4.5.

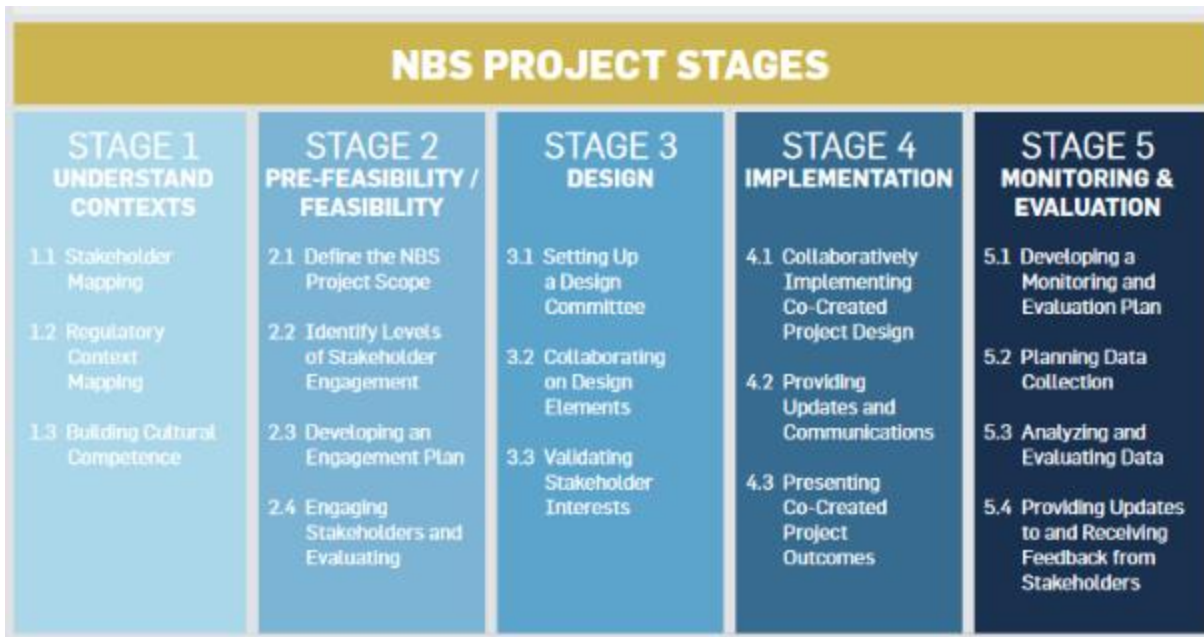


Fig. 4.5 Overview of the stages and steps in stakeholders’ engagement in NBS projects

The same publication includes a suggestion for a *Stakeholder engagement checklist* accountability tool for enabling effective, equitable and transparent engagement.

In a similar publication, called Step-by-step guide for co-production and co-creation of Nature-based Solutions, developed by **Breukers and Jeuken** (2017), technical solutions, methods and tools to empower urban planning decision-making are offered. The guide follows a user-centric approach based on the assumption that citizen and stakeholder engagement is not just one step to be taken, but a necessary transversal aspect of the planning process.

In the publication **Kiss et al.** (2022) the authors analyze current forms and implications of citizen participation in 58 NbS case studies conducted in 21 cities in the light of supporting wider sustainability goals. The citation of their conclusions is:

*“Amidst increasing calls for collaborative governance to support sustainability transitions, there is little empirical evidence regarding the actual contribution of diverse forms of citizen participation to achieve sustainability objectives. This paper addresses this gap, finding clear equity benefits, but unclear environmental outcomes. The poor association between environmental features (such as vegetation growth) and citizen engagement holds especially strong for tokenistic (information provision, consultation) and collaboration-based forms of participation.”*

In the publication **Koutsovili et al. (2023)** the authors analyzed the most common mechanisms of participatory engagement of stakeholders’ surveys, interviews, workshops, scientific dissemination and environmental education activities, which were addressed alone or in combination, to different focused stakeholder groups aiming at more integrated and interdisciplinary results in the Kalloni river basin (Lesvos Island, Greece), which represents a highly flood-prone area.

In the recent publication **Mitincu et al. (2023)** presented interesting and usable approaches to the stakeholders’ involvement in NbS. Here two tables, Tab. 4.1 and 4.2, excerpted from this article are presented.

Tab. 4.1 The general categories of stakeholders involved in NbS planning, design and implementation based on their role (used references can be found in the article)

Categories of stakeholders	Examples of stakeholders	Description of stakeholders’ role
<i>Institutional stakeholders</i>		
National structure	ministries and national agencies in the field of planning, development, environmental protection and conservation, economy	controlling national policies, framing legislative documents, setting national funding priorities and rules
Regional structure	local action groups, water basin administrations	planning, elaboration, implementation, and control of regional policies
County structure	county councils, prefectures, environmental protection agencies	conceptualization, development, application, and monitoring of county policies
Local structure	local councils, town halls, cadaster offices, forest districts	structuration, elaboration, implementation, and control of local policies
<i>Community stakeholders</i>		
Economic agent or private investor	private companies in residential, commercial, industrial development sectors	supporting or financing the implementation and development of policies based on their performed activities
Company or public operator	public companies in water distribution and waste management, energy production sectors	supporting the implementation and development of policies through the provided services
Expert	landscape architects and ecologists, planners, engineers, sociologists, geographers, consultants or consulting companies	giving advice and supporting consensus by having an adaptive and proactive attitude
Research or educational institution	university and pre-university education institutions, research institutes	developing ideas, enriching greater knowledge, and raising awareness
Non-governmental organization	environmental protection, biodiversity, urban and rural development, education, agriculture associations and foundations	exert pressure, advocacy, support, or counteract certain policies or decisions through different actions
Local population	individual citizens, local residents, traditional communities, indigenous groups, segregated groups	express their interests and perspectives regarding certain policies or decisions

Tab. 4.2 The general categories of stakeholders based on their character regarding the diffusion of innovation theory

Categories of stakeholders	Examples of stakeholders	Description of stakeholders' role	References*
Innovator	experts, public and private operators or investors, research or educational institutions	generate new ideas or sustainable innovations	(Goodman et al., 2017)
Change agent	experts, public and private operator or investor	acts as information translator and provider about an innovation to possible adopters	(Rogers, 1995; Hendricks and Calkins, 2006)
Transformer	public and private operator or investor, research or educational institutions	early adopters of an innovation, being eager to support innovative ideas and encourage positive modification	(Rogers, 1995)
Mainstreamer	public and private operator or investor, local population, public institutions	neither in favor nor opposite of changes, they accept an innovation only when everyone does it	(Newman, 2020)
Laggard	public institutions, public and private operator or investor, local population, non-governmental organizations	highly resistant and respond late to change since they are satisfied with their current situation	(Triguero et al., 2016; Aboulnaga and Fousd, 2022)
Reactionary	public and private operator or investor, local population, non-governmental organizations	actively respond to the development of an innovation because consider that their personal interests may be affected	(Wagenet and Pfeffer, 2007)
Controller	public institutions	stand the rules and have the greatest influence in the improvement of the system	(Rydin and Pennington, 2000)

\*References for stakeholders' role description based on existing scientific literature.

The publication **van der Jagt et al. (2023)** emphasizes that all stages of monitoring and assessment should be made more participatory, including the indicator selection, Fig. 4.6.

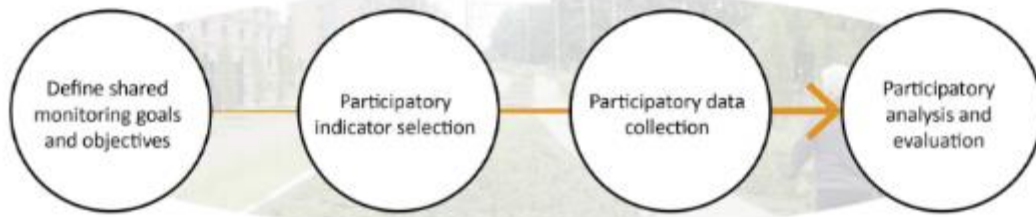


Fig. 4.6 Stages in participatory monitoring and assessment

Citation from the same publication:

*“Locally adapted NBS - which aim to tackle the recovery of degraded, damaged, or destroyed ecosystems, utilise nature to address societal challenges, build resilience and provide environmental, social and economic benefits - can be considered the objective. A (governance) process should be established which reflects these ambitions. Various types of viewpoints, knowledge and expertise are needed in such a process. In other words, multi-sector, multi-stakeholder and multi-scale processes are key to meeting its end.”*

In the publication **Leone et al. (2021)** the Governance triangle, Fig. 4.7, is also presented.

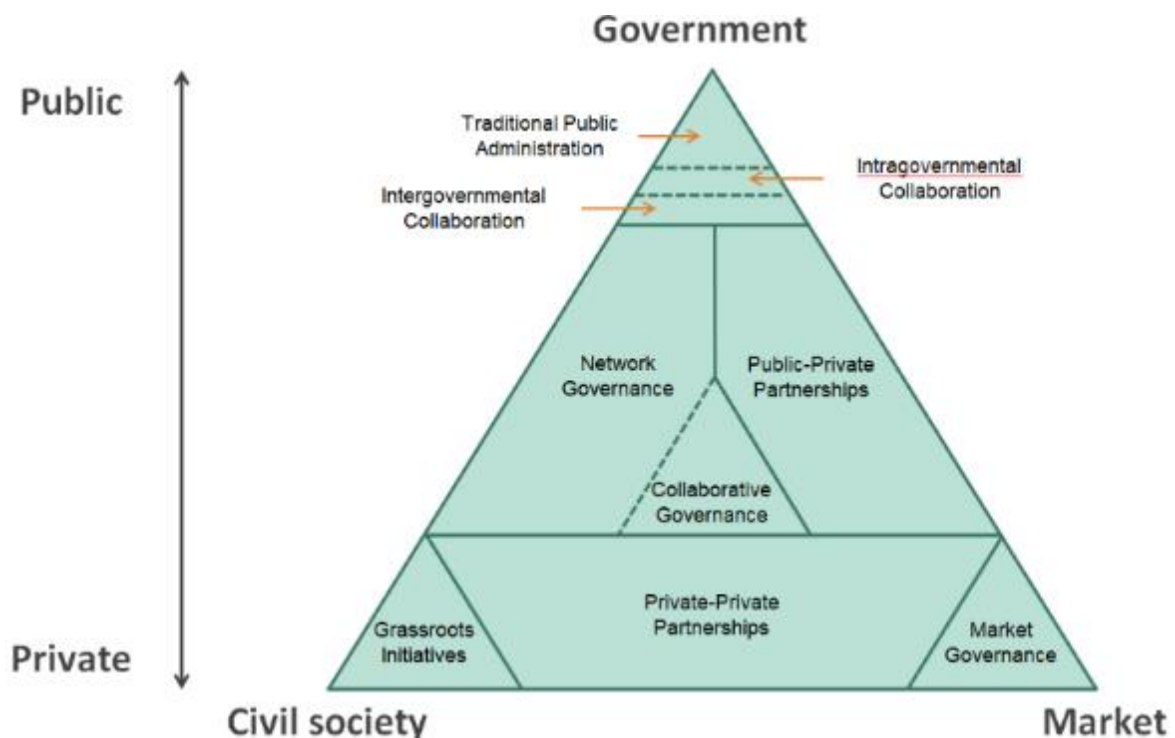


Fig. 4.7 Governance triangle depicting governance forms in which public and private stakeholders collaborate different constellations

NBS realization depends critically on the governance framework that enables the NBS policy process. Even though the number of NBS is increasing, research gaps still exist at the governance level. Research should focus on identifying governance models that are most effective and stimulate innovation. But the results of an overview of the implemented NBS for flood risk management and mitigation, **Zingraff-Hamed et al. (2021)**, show that while no one-

size-fits-all governance model exists, polycentrism is an important commonality between the projects, citation:

*“As a federal state, Germany is characterized by a hierarchical share of competencies and state governments of the 16 states are responsible for policy implementation. The state governments have much flexibility in the NBS planning process making Germany an interesting field for investigation of the design and implementation of NBS under different regional governance models.”*

This suggests that collaborative governance approaches are a key factor for the successful implementation of NBS.

It is also the EU’s intention to encourage NBS implementation via polycentric governance. However, local, historical, and cultural differences in governance approaches cause difficulties in implementing collaborative planning and context conditions seem to influence the governance models applied. It is extremely important that NBS research projects analyze governance models systematically. Future governance will be challenged to adapt traditional governance models to implement large-scale solutions with higher number of stakeholders.

**Martin et al.** (2021) in their publication have defined critical governance enablers of NBS, including polycentric governance (novel arrangements in the public administration that involved multiple institutional scales and/or sectors); co-design (innovative stakeholders’ participatory processes that influenced the final NBS); pro-NBS interest and coalition groups (organized pressure groups that advocated for an NBS); and financial incentives (financing community-based implementation and monitoring of NBS).

In several cases analysed, crucial preconditions for the development of an NBS agenda are underlined, such as a legal mandate and favorable political constellation, fueled by the criticisms of a grey structural model or of a failed enforcement regime. They also stated (citation):

*“Furthermore, a catastrophic event (or a model predicting one) appeared key for opening a window of opportunity for existing pressure groups or sympathetic state authorities. Perhaps the most indispensable precondition was the existence of earmarked budgets or availability of funds, without which an NBS could not have been envisaged.*

*NBS to drive innovative governance arrangements. This was highlighted by the novel working groups and other emerging constellations for cross-scale and cross-sector collaboration. The mainstreaming of NBS into policy agendas, as the three cases illustrate, can be facilitated with polycentric arrangements in public administration that cut across administrative bodies.”*

They claim that the cases analyzed provide evidence of what many consider the near inevitability of hybrid NBS solutions. Governance involves finding compromises that can resolve the interest and value conflicts often underlying the transition from traditional infrastructure to NBS.

Within the Horizon 2020 projects JUST-NATURE and CONEXUS, a Good Governance Nature-based Solutions survey is currently underway. They are considering the following aspects of NBS governance dimensions related to the planning, design and management of nature-based solutions:

1. *Acceptance and uptake*
2. *Advocacy*
3. *Integrated working*
4. *Legislation, regulations & policies*
5. *Strategic and incremental planning process*
6. *Stakeholder networks and partnerships*
7. *Active community engagement*
8. *Monitoring and assessment*
9. *Knowledge development and sharing*
10. *Financing mechanisms*
11. *Valuing diversity, equity and inclusion*
12. *Community-based knowledge*

In the publication of the United Nations Environment Programme, **Anonymous** (2022), related to Nature-based Solutions it is written that, based on the discussions on global, regional, and national levels, NBS can be scaled up to address social, economic, and environmental challenges more effectively. The report:

- i) outlines recent developments on NBS, with a focus on global, regional and national commitments, and key issues and concerns,
- ii) builds on the new multilaterally agreed definition of NBS to set out key elements in the concept, provides examples of NBS, and discusses related approaches, and
- iii) provides recommendations for actions by governments, civil society and the private sector to substantially scale up the use of NBS.

In the report it is also stated (citation):

- *“The opportunity exists for a large scaling up of the use of NbS. This will require integrated approaches that link together policy, financial instruments and technical advances.*
- *Building a common understanding of the nature and value of NbS will be important for scaling up. It is essential to address concerns that have been raised about NbS and to enable actions that respect the rights of indigenous peoples and local communities (IPLCs) and have strong financial, environmental and social integrity.*
- *Empower locally-led action on NbS that is built on respect for the rights of IPLCs, through targeted funding and technical support to local actors.*

- *Robust safeguards, standards and guidance for NbS are critical. These need to be further developed, refined and applied to ensure that NbS are implemented in ways that are effective, gender-responsive, transparent and consensual. Creating cross-sector support and platforms for NbS, increasing and redirecting finance towards NbS, improving technical capacity, and the use of safeguards and standards are all elements of these integrated approaches.”*

Citizens’ engagement is seen as one of the key elements for the EU Mission Ocean & Waters. Effective stakeholder engagement, which should be defined and adopted in NbS project, is paramount for long-term success.

#### 4.4 HEALTH AND WELLBEING

The concept of Nature-based Solutions has evolved as an umbrella concept embracing concepts such as Green/Blue/Nature Infrastructure, Ecosystem Approach, and Ecosystem Services, but at their core, they cluster into the general theme of learning from and using nature to create sustainable socio-ecological systems, which enhance human well-being (HWB).

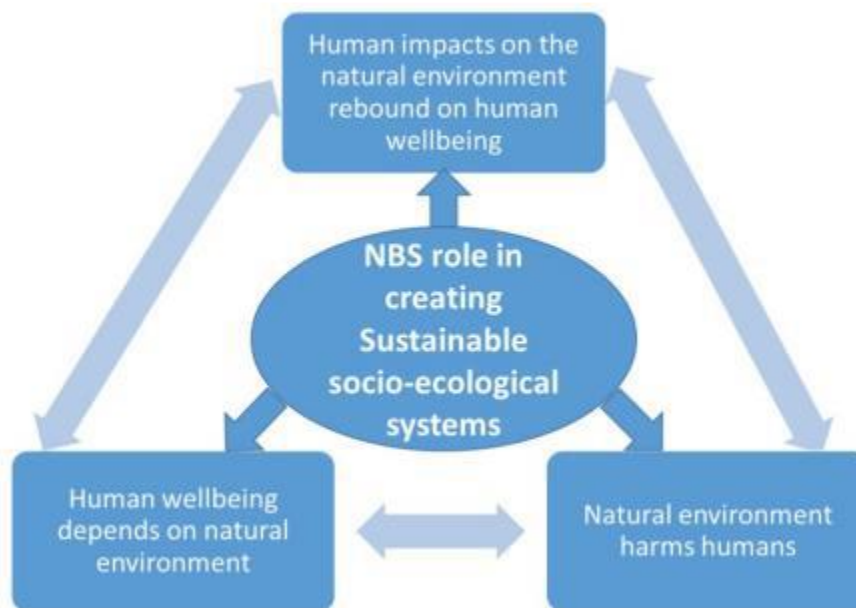


Fig. 4.8 The central role of Nature-based Solutions is to mediate the interactions between the natural environment and human wellbeing (**Dick et al., 2019**)

Nature-based solutions aim to manage natural processes to bring benefits to both people and ecosystems. The starting point of nature-based solutions is societal needs and goals. Nature-based solutions represent a paradigm shift to focus on how restoring ecosystems creates benefits for human well-being, economics, and societies, particularly in terms of building resilience to environmental and climatic changes. In the same publication it is stated that (citation):

*“While there are many reviews and a clear evidence base linking certain NBS to various elements of HWB, particularly urban greenspace and human health, no comprehensive mapping exists of the links between NBS interventions and the*

*associated multiple positive and negative HWB outcomes across a range of habitats.”*

In their review, they tried to find the answer to the question:

*“What evidence is there for nature-based solutions and their impacts on human well-being for societal challenges related to cost-efficacy, governance in planning, environmental justice, and the acoustic environment?”*

The final database of this study can be openly accessed in the Environmental Information Data Centre EIDC data depository ([eidc.ceh.ac.uk](http://eidc.ceh.ac.uk)) and included as an appendix to the systematic map publication.

Biodiversity and ecosystem connectivity and health underpin human well-being, from climate resilience to food and water security, to human health. Investing in Nature-based Solutions to protect, conserve and restore natural (water) ecosystems can offer a catalytic opportunity for health, biodiversity, and climate actors to work together to drive improved health outcomes at the root of the issue. These health and well-being benefits are not just important at the individual level but could if implemented widely save expenditure on health care. Health and well-being represent an emerging and often complex approach to evaluating NBS impact due to issues of causality.

Health and well-being as societal challenges and benefits influenced by NBS in different environments have been discussed and analysed in several additional studies (**Liu et al.**, 2021). According to the already mentioned publication on the relation of NBS to the different SDGs, NBS are directly relevant to SDG 2 (food security), **3 (health and well-being)**, 6 (clean water and sanitation), 10 (reduce inequality), 11 (sustainable cities and communities), 13 (climate change), 14 (conservation and sustainable use of oceans, seas, and marine resources), and 15 (protection, restoration, and promotion of sustainable use of terrestrial ecosystems).

There have been several reviews looking at evidence about the association between human health and natural environments. To date they have tended to focus on either physical health, or social perspectives.

Most of the analyses are dedicated to the applications of NBS in urban environments (for example **Bosch and Sang** (2017) and their influences on health and human well-being which seems to be more obvious than the direct or indirect influence of NBS applications in other habitats (like river basins).

However, no comprehensive review exists of positive and negative human well-being outcomes of NBS interventions enacted to address societal challenges across a range of habitats. There is still a lack of knowledge in terms of monitoring and impact evaluation for people’s benefits (e.g., human health and wellbeing) especially in the case of NBS applied far away from urban areas.

In **Dumitru and Wendling (eds.)**, 2021b, it is stated (citation):

*“Research on complex/multi-dimensional relationship between nature connectedness/nature affiliation (i.e., affective, cognitive and experiential factors related to our belonging to the natural world) and wellbeing indicate that exposure to elements of the natural world affects our well-being by boosting our positive affect, by eliciting feelings of ecstasy, respect, and wonder, by fostering feelings of comfort and friendliness, by heightening our intrinsic aspirations and generosity,*

and by increasing our vitality (**Capaldi et al.**, 2014; **Howell and Passmore**, 2013), highlighted in Recommended indicators 21.3 and 21.4, and Additional indicators 22.11, 22.13, and 22.15.”

Very often the impacts of NBS on health and well-being are expressed in qualitative ways that require high expertise in psycho-social research and cannot be done ad hoc. Further attention to this topic is needed.

## 4.5 NEW ECONOMIC OPPORTUNITIES AND GREEN JOBS

Regarding this challenge area different terms are typically used: cost-effective, economic benefits, new economic opportunities, new jobs, etc. The impact of NBS on the economy and vice-versa are self-evident but a specific approach is needed to deal with this challenge area. The evaluation of this issue is still under development and is mostly treated as uncertain. Common economic appraisal is mostly inadequate, since NBS projects/interventions are most often non-profit. Furthermore the project life span is often long or undefined, meaning that the pay-back period is unknown.

In the publication **FEBA** (2017), already mentioned in chapter 3.3.2, the EbA idea was mentioned as a forerunner of NBS. In this is stated:

*“The difference between EbA and **“business as usual”** is that it links biodiversity and ecosystem conservation approaches with sustainable socio-economic development as part of an overall strategy for helping people adapt to shocks and risks associated with climate change.”*

This is the fact, economic issues of **NBS must not be treated as Business as Usual**.

In the publication of **Dasgupta** (2021), which is not directly related to NBS, it is stated:

*“The economics of biodiversity requires attention to local socio-ecological details. I was introduced to the idea of social capital and its relevance for ecological economics at the biannual retreat that Ismail Serageldin convened for an advisory panel he had constituted in the mid-1990s at the Sustainable Development Vice Presidency of the World Bank.”*

Although the author treated this issue more from the point of view of financial sector and banks, the publication can be used as a basis for elaborating economic issues for NBS developers. It is also noted that **The World Economic Forum** (2020b) conducted a literature review of business opportunities from investing in Nature. They estimate that ecosystem restoration and avoidance of land and ocean use expansion could deliver 11 million more jobs by 2030 through opportunities such as ecotourism, sustainable forestry management and NBS for mitigating climate change.

The author mentioned three groups of private investors: profit, non-profit and philanthropic. The third one could be supported by adequate tax policies.

In **Kuhl and Boyle** (2021), the following statement is presented:

*“Many of the existing toolkits provide guidance on the process of valuation to monetize NbS individual benefits and costs for an aggregate cost-benefit analysis.”*

An excellent toolkit would include:

- *“Theoretical grounding connecting climate, NbS, and the role of cost-benefit analysis*
- *Specific, although not prescriptive, guidance on benefits and costs and how to determine which benefits and cost to include in a cost-benefit analysis*
- *A resource guide to support valuation and modeling/calculations*
- *The resource should be tailored to the geographic area and ecosystems of relevance, including case studies and step-by-step examples using proposed or implemented NbS projects in the area*
- *Discussion of calculation of benefits and costs over time to facilitate long-term planning*
- *Incorporation of climate projections and climate modeling.”*

A typical critique of cost-effectiveness approaches is presented in the publication **Seddon et al. (2020)**:

*“The problem with current evidence for the cost-effectiveness of NbS is that appraisals in general do not use an appropriate framework, and as a result underestimate the economic benefits of working with nature, especially over the long term.”*

Further, the authors, addressed four major relevant issues:

**First**, NbS are often highlighted as multi-functional, with the potential to deliver a wide range of benefits to both local and global communities. Yet, benefits such as food and water security, carbon sequestration and space for recreation, whether locally or beyond the immediate area of implementation, are rarely accounted for. This may be because they are difficult to monetize, or there is high uncertainty about non-market value.

**Second**, appraisals rarely factor in trade-offs among different interventions and ecosystem services, or between stakeholder groups, which may experience the costs and benefits of NbS differently (often reflecting differences in the extent of dependency on natural resources).

**Third**, changes in the provision of ecosystem services over time, for example, under climate change and other stressors, are rarely considered, and there are major questions about how to balance future benefits with current costs. Engineered solutions can usually be implemented with relative certainty about the type and timescale of benefits, whereas NbS generally offer more flexible long-term solutions with benefits that might not be reaped when the costs are felt (or within standard political or electoral cycles).

**Fourth**, perhaps the biggest challenge around estimating the cost-effectiveness of nature-based approaches relates to the variable levels of protection they offer (as discussed above, efficacy can vary with intensity and frequency of threats, the resilience of the ecosystem to withstand climate change impacts and the vulnerabilities of the socioeconomic system). As a result, the response of ecosystems is much harder to predict and cost than engineered/grey infrastructure,

*although recent modelling advances for predicting the efficacy of natural landforms in reducing hazards are helping to reduce this uncertainty.”*

However, the authors are optimistic and expect growing consensus among ecologists, engineers and managers related to compromise about the following: a combination of green and grey may be the best solution in many contexts. Finally, it was concluded:

*“**First**, challenges in measuring or predicting the effectiveness of NbS lead to high uncertainty about their cost-effectiveness compared to alternatives.*

***Second**, poor financial models and flawed approaches to economic appraisal lead to under-investment in NbS.*

***Third**, inflexible and highly sectoralized forms of governance hinder uptake of NbS, with grey, engineered interventions still being the default approach for many climate adaptation and mitigation barriers.*

*Overcoming these challenges requires major systemic change in how we conduct and communicate interdisciplinary research, and how we organize and run our institutions. More fundamentally, fully integrating NbS as solutions to both the climate and biodiversity crises requires a new approach in economic thinking, shifting from a focus on infinite economic growth to a recognition that the energy and material flows needed for human wellbeing must remain within safe biophysical limits.”*

In the publication **Anonymous** (2019) a guidance for NBS business models is presented. For this a simple easy-to-use tool developed in CANVAS, based on **Osterwalder et al.** (2005) is used. This tool supports the initial stages of planning the implementation of NBS, here described for urban areas. Firstly, in Fig. 4.9 costs expected to be incurred for NBS in the three phases of the project are presented. This is useful information for all NBS developers.

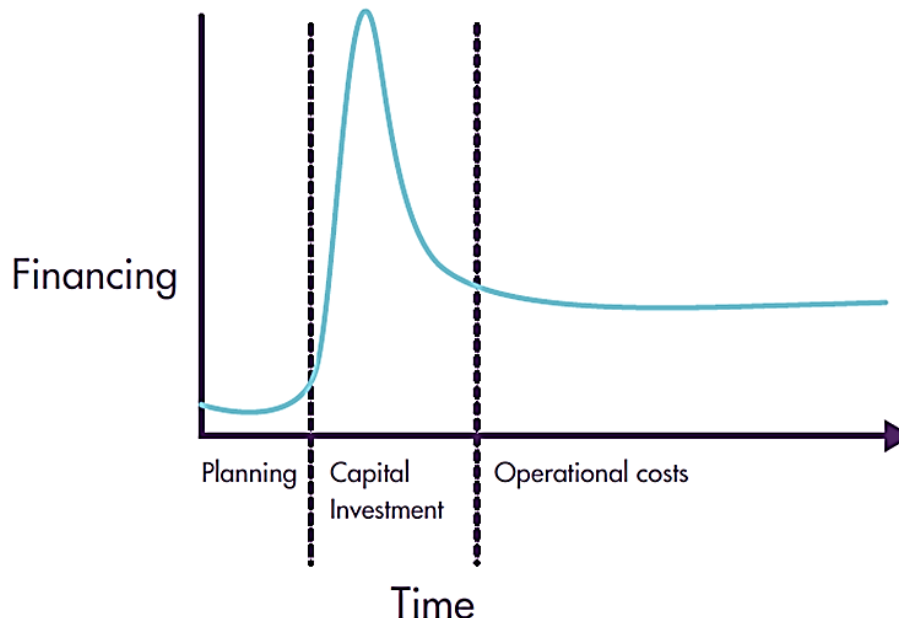


Fig. 4.9 Expected costs during project development and operational phase

How are NBS financed? Citation (partly changed):

*“Small scale urban agriculture projects like community gardens may have a higher mix of community funding secured through instruments like crowd-funding whereas, at the other end of the scale, the financing of large-scale NBS is more similar to public sector infrastructure investment projects. Nature4Cities research found that public financing accounted for the majority of NBS financing with only 9 % financing from financial institutions. This was echoed by Naturvation research which shows 74 % financing from public sector, only 1 % from loan or equity financing and interestingly 8 % from the voluntary sector through donations, community funding etc.”*

Based on examples of three EU projects the shares of different financial sources used are presented in Fig. 4.10.

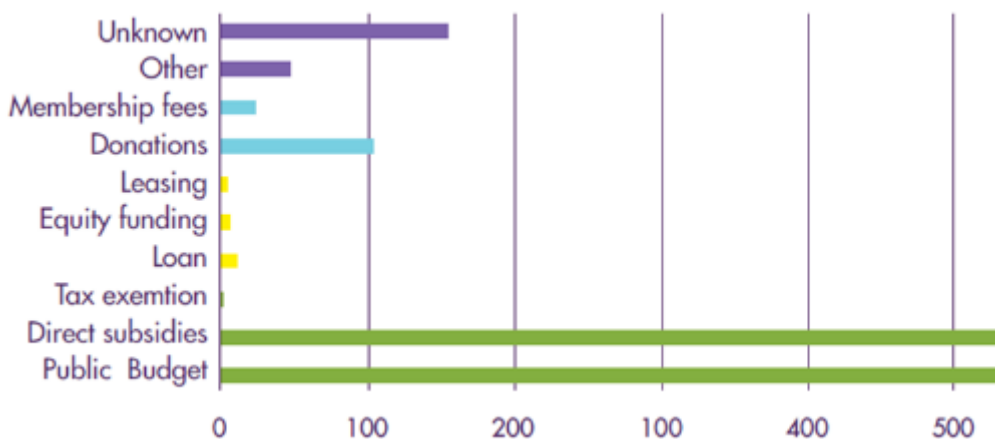


Fig. 4.10 Sources of NBS Financing (Urban Nature Atlas developed within project Naturvation 2018)

In the same source (<https://una.city/>), a list of economic benefits and their respective numbers is created from a collection of more than a thousand inspiring NBS from European cities and beyond, is presented:

- Increase in GDP -5
- Increase of jobs -144
- More sustainable tourism -107
- Increase property prices -42
- Simulate development in deprived areas -82
- Reduce financial costs for urban management -88
- Increase in agricultural production (for profit or not) -144
- Attraction of business and investment -114
- Generation of income from NBS -94
- Increase market share for green economics -28
- Other -93

As previously stated, large scale NBS, are dominantly financed by the public. This requires public procurement. The problems related to this are elaborated in the publication **Mačiulytė and Durieux (2020)**. As main challenges for public procurers are listed:

1. Lack of knowledge and experience with NBS.
2. Lack of NBS typology.
3. Difficulty finding skilled suppliers.
4. Challenges in community engagement.
5. Institutional and legal barriers.
6. Perceived reputational risk.
7. Limited access to funding.

Difficulty of preparing functional Terms of Reference, which should include specificities of emerging NBS features, could be added to this list. Additionally, NBS performance can result in long timescales.

The authors made a review of several EU financed NBS projects and identified difficulties. One of the most important is:

*“Engineering expertise is key for NBS projects: as the market is still developing capacity and skills to deliver NBS projects, it can be difficult to find suppliers with significant experience in this field. Lack of engineering expertise with the features proposed led to costs and quality issues which would have been avoidable by a more experienced project team.”*

Authors suggested lists of activities aimed to facilitate NBS procurement for listed actors:

1. EU recommendations (Support the development of key NBS performance indicators).
2. Actions for national governments.
3. Actions for city administrations.
4. Actions for public procurers.

This publication could be useful for all NBS developers.

The publication **Mayor et al. (2019)** is the deliverable *International Good practices in Financing and Funding Nature Restoration*, of the EU project NAIAD (*NAture Insurance value: Assessment and Demonstration*). This deliverable provides an overview of successful examples of funding and financing strategies to implement ecosystem conservation and nature-based solutions (NBS) projects to address water related risks, including floods, droughts, water quality degradation, wildfires, and associated impacts on water pollution, among others. Among others, the following three annexes of the publication contain useful information and are therefore of special interest:

Annex 1. Detailed reported examples of NAS (Natural Assurance Schemes) or NAS described through the NAS canvas framework (Examples of successful watershed scale natural assurance scheme interventions.)

Annex 2. Examples of successful financing facilities

Annex 3. Examples of successful Financial Instruments

Much more complex is the publication **Mayor et al. (2021)**. It presents the contributions from a set of H2020 (mostly urban areas related) projects that have addressed the NBS

business models knowledge gaps and an overview of findings and tools that produced a knowledge baseline on business models for NBS.

The term business model is commonly associated with business entities, yet NBS are not enterprises but rather sustainability interventions. The authors were involved in the creation of one business model, in a previous publication and Fig. 4.11, and they have stated:

*“Although the merit of applying the business model concept is apparent in the current work, we suggest further theoretical reflection on the appropriateness of the business model concept in the context of sustainable interventions, such as NBS.”*

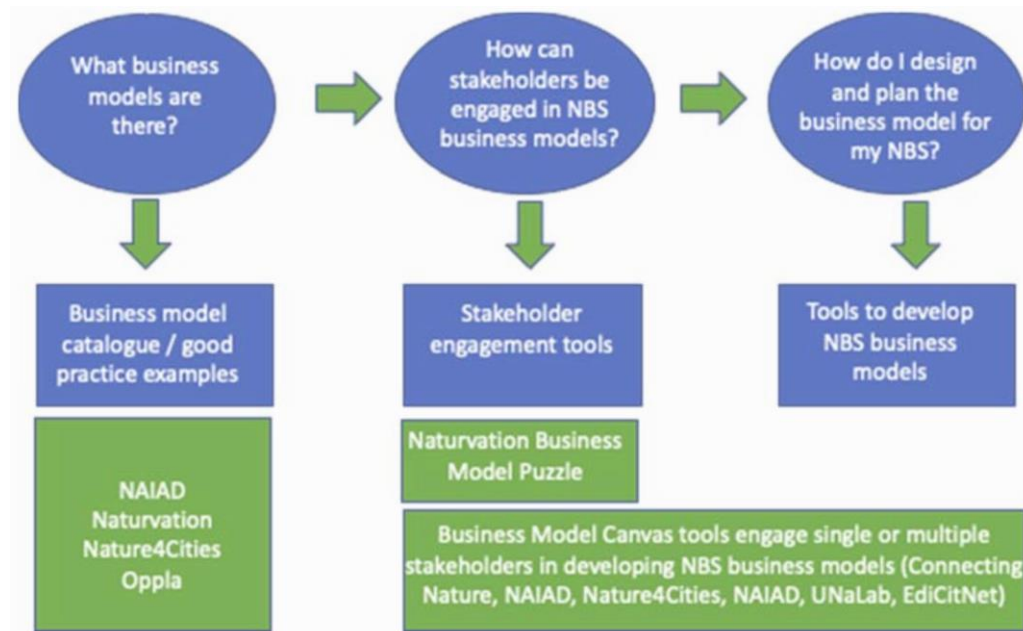


Fig. 4.11 Three types of business model support instruments from H2020 projects

The big challenge is to make NBS value both monetary and non-monetary measurable. The dominant sources of funds are public. How to attract private investors is still to be clarified. Economic benefits are even more unclear and could be easily measurable in the case of cost reduction for construction and engineering phase. Another problem is to secure finances for operational costs.

Finally, it was concluded:

*“Notwithstanding the need for further research, this study concludes that business models are a vital tool in the arsenal of NBS project promoters, facilitating the engagement of public, private, and community stakeholders in setting out a consensual roadmap for the long-term sustainable financing of NBS.”*

**McQuaid et al.** (2021), White Paper, introduced the new term Nature-based Economy, as follows:

*“The Nature-based Economy encompasses all production, exchange and consumption processes related to activities concerned with the protection, conservation, restoration and sustainable use of natural resources by consumers, industry and society at large.”*

The authors and contributors of this position paper were participants in relevant EU projects. Their recommendations started with the statement: there is no future for 'business as usual'. Measures aimed to support NBS and Nature-based Economy are proposed on:

- I. Global level
- II. EU level
- III. At national and local government level.

Among the many proposed measures the “Increased valuation of non-monetary benefits of NBS” is especially interesting. Generally, this publication encourages future NBS developers, especially those related to finances and economic opportunities.

In **McQuaid et al. (2022)** the need for a change of approach to NBS economy, as described in the previous publication, is additionally elaborated. Here the term Nature Positive Economy is introduced. In this article some interesting cases of NBS projects are presented, with a special focus on the issue of economic opportunities, reviewed sources for financing, expected future development of Nature-based Economy and its application and support. In Fig. 4.12 barriers and enablers are presented using PESTES.

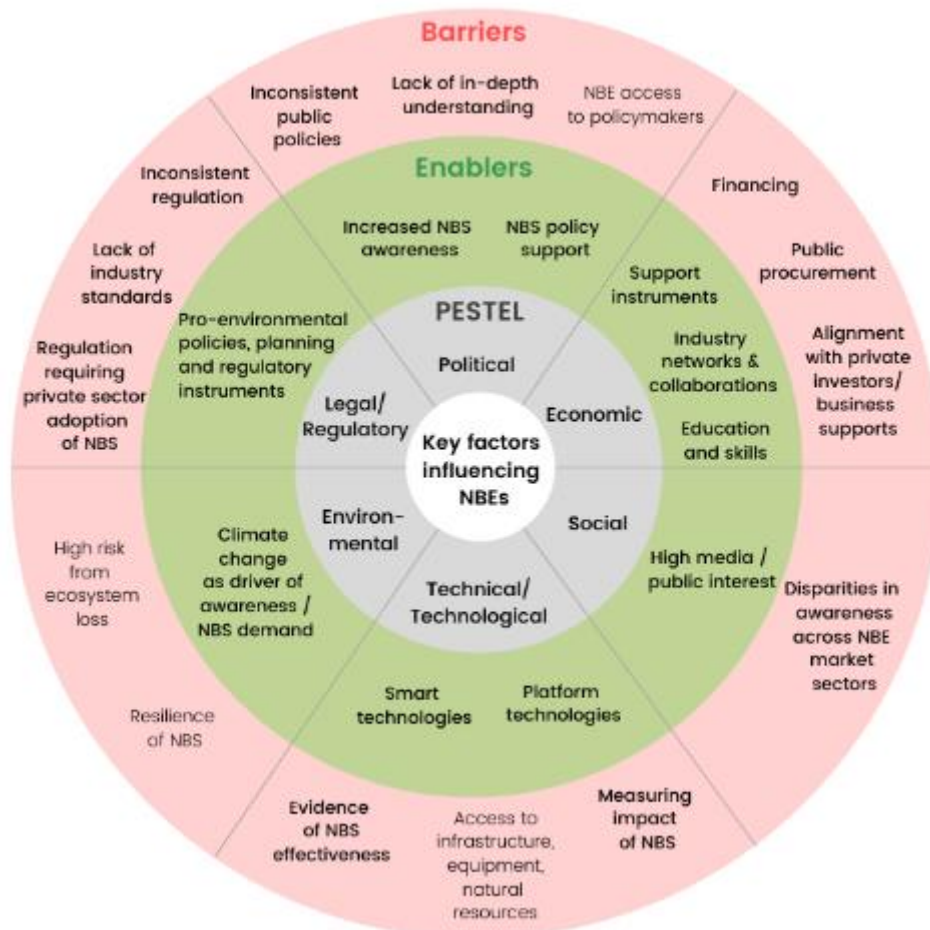


Fig. 4.12 Key factors influencing Nature-Based Enterprises. Influencing factors highlighted in bold were identified in the literature, surveys, and interviews

The publication can be recommended to NBS developers.

## 4.6 DANUBE RIVER BASIN RESTORATION RELEVANCES

This chapter is related generally to the challenge area Water Management and focuses on the Danube River Basin.

In the UNO document **WWAP (United Nations World Water Assessment Programme)/UN-Water**, 2018, NBS for waters in general are elaborated. Special attention is paid to correlation with UNO SDGs, cited:

*“NBS offer high potential to contribute to the achievement of most of the targets of SDG 6 (on water). Areas in which this contribution translates into particularly striking positive direct impacts on other SDGs are with regards to water security for underpinning sustainable agriculture (SDG 2, notably Target 2.4), healthy lives (SDG 3), building resilient (water-related) infrastructure (SDG 9), sustainable urban settlements (SDG 11) and disaster risk reduction (SDG 11 and, as related to climate change, SDG 13).”*

The novelty of the NBS approach in comparison with previous approaches, also focused on sustainable development, is well presented in Fig. 4.13. The difference is in new, firstly societal, benefits and co-benefits.

All aspects of water use and management, and restoration, including biodiversity and connectivity problem, are elaborated. Difficulties with diverse stakeholders engagement and cost aspects are mentioned as limitations, citation:

*“An often overstated assumption about NBS is that they are ‘cost-effective’, whereas this should be established during an assessment, including consideration of co-benefits.”*

This publication could be helpful in considering some ideas for new projects/interventions.

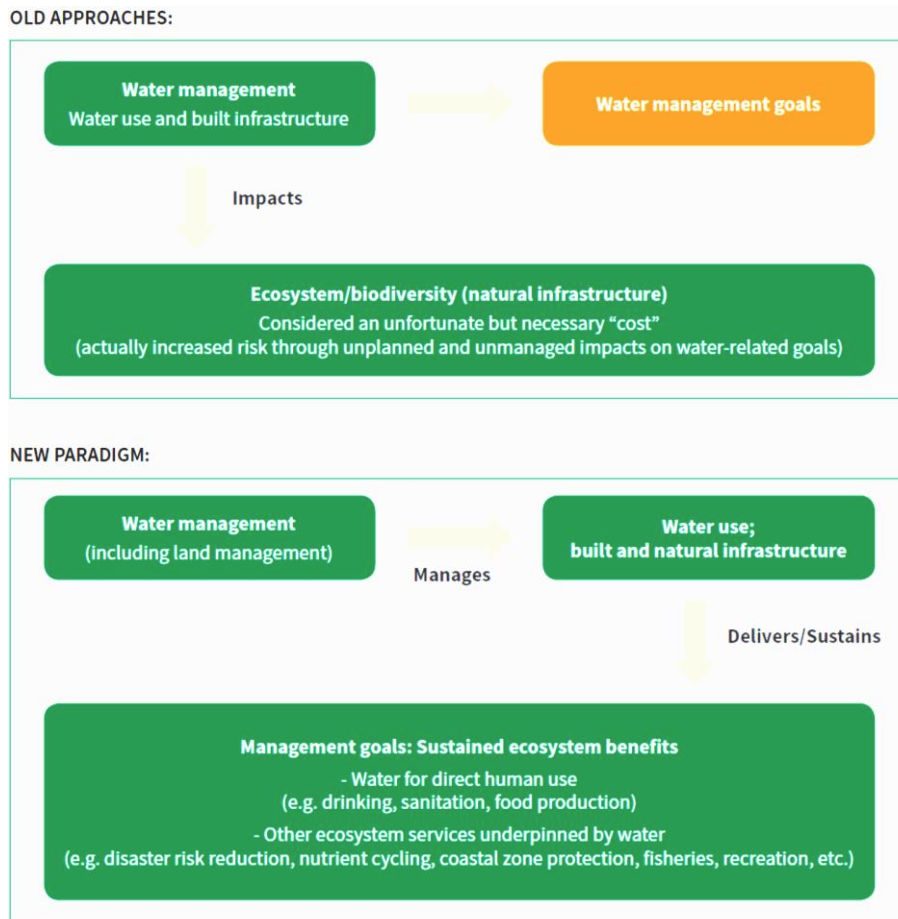


Fig. 4.13 NBS vs. previous approach (Coates and Smith, 2012)

Very significant for potential restoration projects/intervention as NBS is a recent publication *Baseline study for the implementation of lighthouses of the Mission “Restore our ocean and waters by 2030...”* (Alao Chanou et al., 2023), which includes only one river, the Danube. It defines two general targets for the Danube river (citation):

**“Target 1:** Restore at least 25 000 km of free-flowing rivers in Europe. Most European rivers, including the Danube, are interrupted due to human interventions, such as dams or other structures. Barriers alter a river’s natural flow, lead to shifts in sediment transportation, limit fish and other species’ ability to migrate both up- and downstream. Barriers also lead to habitats being fragmented. As a result, the living environment of aquatic species and the ecosystem as a whole is compromised. The European Commission published a Guidance document on barrier removal for river restoration in late 2021 stating that: the concept of free-flowing rivers is mainly to be achieved through barrier removal and the restoration of floodplains and wetlands. The guidance names various reasons for the close interlinkage of the Water Framework Directive (WFD), as well as the Birds and Habitats Directives. For instance, in Biodiversity Strategy (BDS)’ work river function units are based on the WFD work and existing legislation through the Birds and Habitats Directive is acknowledged. These laws are the cornerstones of EU nature protection policy and have brought about the creation of Natura 2000, the world’s biggest network of protected areas. This matters, because the proper fulfilment of river restoration measures is seen as a key step towards reaching the biodiversity

targets, according to the European Environment Bureau. According to the European Commission mitigation measures, such as fish ladders can be effective, but often the removal of barriers is necessary to enable fish migration and especially the unfolding of the entire aquatic ecosystem.

In the past 30 years there has been a mix of small to large scale barrier removal and renaturation activities in the Danube. The projects differ from the planning phase and the funding schemes, as well as the operational implementation. For a description of the current situation in the Danube regarding target 1, see the Task 2 report.

**Target 2:** Contribute to relevant upcoming nature restoration targets, including degraded seabed habitats and coastal ecosystems. This target is closely linked and based on the EU restoration law, which was planned to be published by the end of 2021 (Commission proposal for a regulation). The publication has been postponed, and it has been reported that it will likely only be published in summer 2022. Hence, the exact specifics of target 2 are not yet clear. For a description of the current situation in the Danube regarding target 2, see the Task 2 report.

Several regional, i.e., basin-wide organizations are active in the Danube River Basin. As the Danube region is composed of countries organized in diverse political systems, the local and regional governance capacities vary. According to the European Regional Competitiveness Index<sup>351</sup>, the best performing regional institutions are in Germany and Austria (average 69 and 68 points respectively) while the lowest average scores are in Bulgaria and Romania (6.6 and 14.6 respectively). Common challenges across the region are climate change (changing precipitation patterns, increasing risks of drought), ageing populations and the impact of the COVID pandemic, but certain challenges vary depending on geography and socio-economics: the type of region (rural-urban), the position of a country (upstream/downstream), on the GDP level, status of EU membership, structure of the state (centralised-decentralised). The basin contains EU and non-EU, high- and low-income countries, with different socio-economic backgrounds. This is illustrated by the cohesion policy status of the Danube region, with only 17 (approximately 40%) of the NUTS2 regions considered as “more developed” while the large majority is “less developed” and only 3 are “in transition”.

The Water Framework Directive (2000/60/EC), and other EU documents listed in chapter 4.2, are relevant for the topic of EcoDaLLi in this chapter.

In this respect the ICPDR – *International Commission for the Protection of the Danube River*, Vienna is an important and pertinent institution. It offers a considerable number of usable publications. The ICPDR also offers maps of the diverse characteristics of the DRB. One example is presented in Fig. 4.15.

In **Schmutz and Mielach** (2013) engineering solutions for fish passes, as well as data for fishes are presented. In **Anonymous** (2014c) it is written:

*“The Danube’s remaining large floodplain forests and the Danube Delta are the last refuges in continental Europe for the white-tailed eagle and white pelicans.*

*Beavers have been successfully reintroduced in the upper and middle Danube despite being driven to near extinction. The Beluga Sturgeon, one of the oldest*

*species of bony fish in existence and one of six sturgeon species once native to the Danube, is an important icon for the ICPDR.”*

This publication is focused on the existing problem of fish’s obstacles, of which the Iron Gate I and II hydro power plants are the biggest. In chapter 4.2 a publication **Masliah-Gilkarov (2021)** is mentioned, where results obtained by EU supported initiative of a few institutions in the region are presented. In the brochure the acoustic telemetry technology applied for following fishes passing up- and downstreams of the dams in Iron Gate region, Fig. 4.14 is presented.

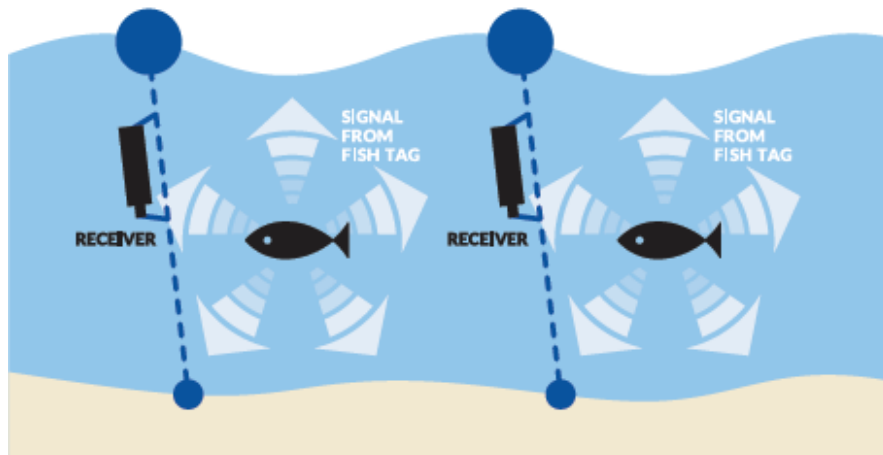


Fig. 4.14 Acoustic identification of passing fishes

The Joint Research Centre, JRC, an EU research institution, elaborated issues of rivers, and especially the Danube.

In the publication **Maes et al. (2020)** of the European Commission JRC Fact sheets for relevant water characteristics are presented. These can be perfectly used as indicators, and will be elaborated in chapter 5.2. Here some of them that are of special interest to the EcoDaLLi project are listed:

1. Wetland connectivity
2. Article 17 (of habitats Directive) habitat conservation status
3. Land cover in riparian areas
4. Number of newly introduced non-indigenous species
5. Hydromorphological alteration (density of infrastructures in riparian areas)
6. Number of newly introduced non-indigenous species
7. Pressure by Invasive Alien Species on freshwater ecosystems

**Pistocchi et al. (2020)** presented the status in DRB and identified problems. It was written:

*“About 50% of the surface water bodies do not achieve good water quality status yet, and are unlikely to achieve it by 2021.”*

The critical comments about potential restoration are included in the chapter: *Challenges with hydromorphological restoration: good to have, but just a little.* Citation:

*“Under Scenario 1, lobbies may push competitive agendas (such as hydropower and navigation), while river preservation or restoration may be limited only to the best sites in terms of natural and scenic richness.*

*Under Scenario 2, restoration projects may lack scale and ambitious projects (such as dam removal or large scale floodplain reconnection) may be difficult to finance. Moreover, certain regions may be tempted by a “race to the bottom” and accept exemptions to hydromorphological quality objectives in the name of economic development.*

*Under Scenario 3, hydromorphological restoration may attract limited interest by investors in the absence of a bold and stable funding mechanism. On the contrary, the reasons of the global supply chains may tend to push for logistics (hence possibly navigation and anyway infrastructure in the floodplains) eventually conflicting with habitat restoration goals.*

*Under Scenario 4, governments may fail to identify common objectives for large scale coordinated actions (e.g. for flood mitigation or fish migration) and hydromorphological restoration unrolls at the local level where conditions may be favourable, but fails to upscale to mainstream practice.”*

This ascertainment is not positive for the future of NBS.

The publication **Pistocchi (ed.)** (2022) refers to water and agriculture. Although it is not directly related to the EcoDaLLi project, some parts have relevancies to it.

In **Wild** (2020) selected results of all (in this time ongoing or finished) EU projects focusing on water quality and water bodies are presented and the projects and their web sites are listed. These can be a useful basis for future R&I projects and NBSs.

An ecological prioritisation of measures to restore river and habitat continuity in the Danube River Basin was carried out for the Danube River Basin Management Plan –DRBMP 2009. Overall, the ecological prioritisation approach was continued and updated in the 2021, (**Anonymous. 2021a.**) ICPDR – International Commission for the Protection of the Danube River published in (**Anonymous. 2021b**) diverse maps. The relevant map 36 is presented in Fig. 4.15.

## COMMENTS

This chapter discusses aspects of societal challenges relevant to EcoDaLLi's planned methodology, highlighting the following significant areas: 1. Water Management

2. Biodiversity Enhancement
3. Participatory Planning and Governance
4. Health and Wellbeing
5. New Economic Opportunities and Green Jobs

It was noted that other challenges may also be included depending on the specific characteristics of the project, such as water quality.

For project developers and practitioners, understanding and addressing challenges 3, 4, and 5 is essential. Therefore, these areas have been elaborated upon and explained in detail in this chapter.

Furthermore, useful instructions for Biodiversity Enhancement and connectivity issues relevant to Mission Ocean and Waters have also been prepared. Particularly for Biodiversity Enhancement, it is emphasized that free-flowing rivers are crucial. Additionally, the connectivity of all surface water bodies and wetlands significantly contributes to the restoration of flora and fauna. Relevant examples for the Danube River Basin (DRB) are provided.

Author's remark: reduction of plastic and microplastics litter, agricultural nutrients and pesticides should be included as tasks in Danube Lighthouse.



Fig. 4.15 Ecological prioritization regarding restoration measures for river and habitat continuity

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## 5. INDICATORS

Indicators are a tool for evaluation of area's status in relation to planned enhancements, restoration, and are especially useful for validation of the project/intervention as NBS. Selection of pertinent indicators is of crucial importance for proper assessment of NBS and evaluation of performances. Indicators are expected to be in line with EU policies and SDGs.

This chapter is developed drawing on knowledge from EU projects, documents, and policies.

In the reviewed references diverse type of indicators have been used, based on their function. Here some of these types are mentioned:

- General or universal.
- Relevant to certain policies.
- Quantitative and qualitative indicators.
- Core and feature indicators.
- Key performance indicators, KPI.
- Structural, process focused, outcome-based.
- Bio indicators etc.

Selection of proper indicators is decisive for assessment and evaluation of NBS. They should be efficient and cost-effective. Number of indicators should be selected appropriate to obtain expected results but not higher than necessary.

In the publications **Anonymous** (2017) and **DEVCO** (2016) the term **RACER** is introduced for desirable characteristics of indicators. RACER is the abbreviation for "Relevant, Acceptable, Credible, Easy, Robust", cited:

### ***“Relevant***

*The indicator should have a strong correlation with the objective that we want to achieve; this means for instance that broad, composite indexes such as the Ecological Footprint (3) or the Environmental Sustainability Index (4) (ESI) should not be used to monitor the performance of specific sector policies or programmes; or, to give another example, when concerned with following the evolution of fish stocks, we should not monitor the fish catch only, since high fish catches may reflect a high fishing pressure as well as a recovery of fish stocks.*

### ***Acceptable***

*The indicator must be easily understood and should be accepted by all the stakeholders.*

### ***Credible***

*The indicators must be accessible to non-experts, unambiguous and easy to interpret.*

### ***Easy***

*It should be possible to collect the data with available resources, based on the principle of 'proportionate analysis'; when we want to conserve forest biodiversity, for instance, we cannot envisage a census of all species living in the area but we have to identify species or 'objects' (like elephant dung) that are easily detectable; relative census methods should usually be preferred, since they are more cost-effective and usually sufficient to track changes in time.*

### **Robust**

*The indicators should be sensitive enough to monitor changes therefore, it is important to select the indicators according to the time-lag between the action and the expected change; when we monitor environmental impacts, we should be aware that the change should be noticed before it is already too late to adapt the intervention; for this reason it is important not to rely on (a) old data; (b) indicators that, having been developed for comparing countries (such as the ESI) or situations, are not suitable for monitoring changes; (c) variables influenced by long term impacts; (d) variables that are deeply affected by uncontrolled short-term changes hiding the expected long-term changes. For sustainable development, a major challenge is to find indicators that point to current progress towards long-term or future improvements: these indicators include indicators of 'capital' or 'stock' (e.g. of natural resources) and, from an economic perspective, the genuine saving rates (adjusted net saving)."*

In **Anonymous** (2017) are proposed types of indicators, citation:

**“Input indicators:** Input indicators measure the financial, human, material, administrative and regulatory resources needed to implement a policy/programme (**Delorme and Chatelain**, 2011, **DEVCO**, 2012). Those for the assessment of a social protection scheme's technical or administrative efficiency relate mainly to human and other resources used to provide benefits and services (e.g. administrative costs, personnel) (**Gassmann**, 2010). Resources used to finance social protection are input indicators used to assess allocative efficiency (*ibid*). As we discuss in Section 4, the majority of input indicators used by international donors in the social protection sector focus on measuring the allocation of financial resources to social protection as a sign of political commitment. Typical input indicators are government spending on social protection as a percentage of gross domestic product (GDP) or government spending on social protection as a percentage of total public expenditure.

**Process indicators:** These refer to the activities that turn inputs into outputs. They might include legislation drafted, training conducted etc.

**Output indicators:** These measure the immediate and concrete consequences of the resources used and measures taken (**DEVCO**, 2012). In the social protection sector, this refers to the quantitative capacity of the system and its quality, which are under the control of the agency that produces them (**Gassmann**, 2010). For example, as Section 4 discusses, output measurements in the social protection sector tend to focus primarily on the number of beneficiaries receiving social protection, or in the case of public works, the number of people employed, or the total number of days of work created.

**Outcome indicators:** Outcome indicators measure the direct effects on beneficiaries (**Delorme and Chatelain, 2011, DEVCO, 2012**). As we find in Section 4, in the social protection sector, outcome indicators mainly focus on programme coverage, targeting effectiveness or the adequacy of benefits (the value in relation to a poverty line).

**Impact indicators:** Impact indicators measure the consequences of the outcomes and the achievements towards the overall policy objective (**DEVCO, 2012**), such as level of poverty reduction, improved living standards and overall well-being of the poor and vulnerable (**Gassmann, 2010**). These are the ultimate goals of social protection policies. As Section 4 discusses, examples of impact indicators include reductions in the poverty gap and headcount, Gini inequality and levels of food insecurity.”

However, these indicators are relevant to measuring social protection performance (Implications for EC programming). The process indicators are of crucial importance for NBS developer, and can perhaps be compared with KPI.










The overall evaluation of NBS should be performed by comparing the status before the start of the project and the statues after a defined time or time scale has passed. This is calculated based on changes in measured indicators’ values. However, for correct definition of obtained improvements it should be considered that indicators have different “weights”. This approach is mentioned in many publications. One example is presented in **Autuori, et al. (2019)**. The Indicator Weight  $w_{j,i}$  of each Indicator  $I_j$  has a value between 0 to 1, whereby the sum of all is 1.

$$0 \leq w_{j,i} \leq 1 \quad \text{and} \quad \sum_{j=1}^n w_{j,i} = 1$$

It is also possible to use another classification of the indicators’ weight.

The metric, or quantitative measuring and expression of indicator values is clear. For qualitative evaluation diverse solutions are used. One example is presented in Tab. 3.2.

In **Bahlmann (2019)** a wider spectrum of evaluation is used as presented in the following table.

Score	Colour	Meaning	Symbol
5		Very high positive impact	+++++
4		High positive impact	++++
3		Medium positive impact	+++
2		Low positive impact	++
1		Very low positive impact	+
0		No impact	o
-1		Low negative impact	-
-2		Medium negative impact	--
-3		High negative impact	---

Note that this kind of evaluation of indicators is still not standardized.

The recent publications are considerably more applicable for NBS performers, due to rapid development in this sector. But the work on defining indicators is not new. Let's start with a relatively old publication developed by the European Environment Agency, **Delbare** (2003). In the publication a list of 12 classes (sectors/themes) of indicators was presented:

Biodiversity-related indicators		
Sectors/themes	Indicators listed	(%)
Nature protection	387	58
Forestry	78	12
Energy	1	0
Recreation/tourism	4	1
Climate change	12	2
Urban development	4	1
Rural development	0	0
Water	43	7
Infrastructure/transport	11	2
Trade	2	0
Fisheries	22	3
Agriculture	91	14

Although this terminology does not fit into a contemporary setting, it could be useful for selection of indicators. In the following table, an excerpt from the publication, an example of listed content is demonstrated.

### Nature protection

Biodiversity-related indicators, Inventory January 2002, Nature protection

No	DPSIR	Indicator name and definition	Use	Information source
1	S	Species richness (number of species, number of species per unit area, and number of species per habitat type)	Implemented	Reid et al., 1993; UNEP, 2001
2	S	Species (populations) threatened with extinction (number or percentage)	Developed	Reid et al., 1993
3	S	Species (populations) threatened with extirpation (number or percentage)	Developed	Reid et al., 1993
4	S	Endemic species (number or percentage)	Developed	Reid et al., 1993
5	S	Endemic species threatened with extinction (number or percentage)	Implemented	Reid et al., 1993; UNEP, 2001
6	S	Species risk index (number of endemic species per unit area in a community multiplied by the percentage of the natural community that has been lost)	Implemented	Reid et al., 1993; UNEP, 2001
7	S	Species (populations) with stable or increasing populations (number or percentage)	Implemented	Reid et al., 1993
8	S	Species (populations) with stable or decreasing populations (number or percentage)	Implemented	Reid et al., 1993
9	S	Threatened species in protected areas (number or percentage)	Implemented	Reid et al., 1993; UNEP, 2001
10	S	Endemic species in protected areas (number or percentage)	Implemented	Reid et al., 1993; UNEP, 2001

DBSIR is abbreviation for the function: Driving force–Pressure–State–Impact–Response (monitoring framework EEA).

In the summary it is written:

*“1. There is an enormous variety of indicators that have been developed to assess aspects of biodiversity at the national, international or global scale.*

*2. Many indicators have been proposed or developed, but only a limited number of them are actually in use on a regular basis. etc.”*

In any case, this source could be useful for developers and evaluators of NBS for indicator selection. Of course, recently new indicators and methods for their utilization have been developed.

This work was continued and in 2010 created the Streamlining European Biodiversity Indicators (SEBI) process. In the publication **Biala, et al.** (2012) authors presented activities and results, as well as references for potential users of indicators.

## 5.1 DANUBE RIVER BASIN LIGHTHOUSE

In the publication *Baseline study for the implementation of lighthouses of the Mission ‘Restore our ocean and waters by 2030’: Atlantic, Arctic, Danube and Mediterranean lighthouses, Final report (Alao Chanou, et al, 2023)*, policy indicators for Danube River basin lighthouse are presented. Citation:

*“Key elements for the indicator framework, aligned to the mission targets, include (but are not limited to) the following elements:*

*“1) Indicators related to the target of restoration of 25 000 km of free-flowing river*

- Hydrological alterations and river morphology (length of river stretches), to measure how well the river provides a habitat for sediment, fish and other species.*
- Wetlands/floodplains with potential for reconnection and those reconnected, because it is important from a species perspective, that the bank top vegetation and surrounding terrestrial area is rather natural.*
- Interruptions of river continuity for fish migration, because the interruptions of fish migration are a key measure of the (absence of) free flowing rivers.*

*2) Indicators for proposed nature restoration targets*

- Number, surface area and status of protected areas in river, lake and transitional waters, as well as those in coastal waters and relevant marine areas, to assess what the share of protected areas is (in the different areas) respectively and evaluate how they (potentially also depending on their size) they protect wildlife and ecosystems due to their protected status.*
- status of freshwater habitats, to show qualitatively and quantitatively how well the aquatic systems serve as habitats.*

3) Indicators related to Good Ecological Status under the Water Framework Directive serving both targets

- Ecological status of water bodies (WFD), because free flowing rivers and nature restoration seek to restore freshwater ecosystems, and this is a key measure of that underlying goal.”

Key indicators related to the target on restoration of 25.000 km of free-flowing river are:

Outcomes:	Indicators	Data source
Target 1	Number of measures and length of restored river stretches	
	Hydrological alterations - Expected Restoration Measures by 2027 (length of restored river stretches)	ICPDR. (2021). Danube River Basin Management Plan Part A-Basin-wide overview Update 2021 – plus future updates. <a href="http://www.icpdr.org">www.icpdr.org</a>
	Alterations of river Morphology - Expected Restoration Measures by 2027 (length of restored river stretches)	
	Interruptions of River continuity for Fish Migration - Expected Restoration Measures by 2027 (number of removed interruptions)	
	Wetlands/Floodplains with Reconnection Potential - Expected Restoration Measures by 2027 (number of reconnected wetlands/floodplains)	
Impacts: Target 1	Increase in free-flowing river sections	
	Free-flowing river stretches (length of river stretches)	ICPDR. (2021). Danube River Basin Management Plan Part A-Basin-wide overview Update 2021 – and future updates. <a href="http://www.icpdr.org">www.icpdr.org</a>

In the same publication, three groups of indicators are listed (these groups are presented in publication Anonymous (2017)).

## I Output indicators

Indicator	Unit	Comments
Length of rivers covered by Mission projects	km	Aggregated by MS/third country and RBD. Referring to both targets for the Danube.
Number of artificial barriers on rivers identified, mapped and analysed by the Mission	Number	Aggregated by MS/third country and RBD. Referring to Danube target 1: free-flowing rivers
Number of habitat sites mapped and analysed by the Mission	Number	Aggregated by MS/third country and RBD; and by freshwater habitat types listed in Annex I of the Proposal for a Regulation on nature restoration.
Number of innovative solutions and tools for river/habitat restoration developed in Mission projects	Number	Innovative solutions can include technical, social and financial solutions. Aggregated by Mission area and target, MS/third country RBD.
Number of artificial barriers to river connectivity removed by Mission projects.	Number km	Artificial structures affecting the free-flowing character of water, sediment, nutrients, matter and organisms along river systems. Aggregated by MS/third country and RBD. Can be aggregated per dimension as in barriers to longitudinal, lateral, vertical, and or temporal connectivity; per partial and fully removed barrier; and per obsolete and non-obsolete barrier.  Referring to Danube target 1: free-flowing rivers
Restoration measures taken by Mission projects to improve the condition of habitats to good status	Number km <sup>2</sup>	Aggregated per MS/third country, RBD, and freshwater habitat types listed in Annex I of the Proposal for a Regulation on nature restoration.  Referring to Danube target 2: nature restoration

## II Outcome indicators

Outcome indicator	Unit	Comments
Number of measures and length of restored river stretches	Number km	Implementation of the following types of expected restoration measures (by 2027) identified by ICPDR: Measures addressing hydrological alterations Measures addressing alterations of river morphology Measures addressing interruptions of river continuity for fish migration Measures to reconnect wetlands/floodplains  Number of measures and length of restored river stretches. Measures implemented by Mission projects and partner actions.  <i>Data sources: ICPDR; mission projects</i> <i>Referring to target 1: free-flowing rivers</i>
Designation of new or enlarged protected areas to maintain or improve freshwater and coastal habitat conditions	Number km <sup>2</sup>	Can be aggregated per MS/third country and freshwater habitat types listed in Annex I of the Proposal for a regulation on nature restoration Designations linked to measures implemented by Mission projects and partner actions. <i>Data sources: mission projects</i> <i>Referring to target 2: nature restoration</i>
Increase in free-flowing river sections	km	Increase due to Mission projects and partner actions. Will need to be developed based on an agreed definition of a free-flowing river (potentially drawing on CIS <a href="#">guidance document</a> and other sources). Aggregated per MS/third country, RBD. <i>Data sources: ICPDR; mission projects.</i> <i>Referring to target 1: free-flowing rivers</i>
Improvements in land-use within 25m of river banktop and improvements in river bankface vegetation	Bankface: m <sup>2</sup> banktop: km <sup>2</sup>	Measuring horizontal river connectivity. Improvements linked to measures implemented by Mission projects and partner actions. Check of land-use at the banktop of the river. Check of vegetation type at river bankface and classification into bare, uniform, simple, complex, depending on species diversity

## I Impact indicators

Impact indicator	Unit	Comments
Improvement in freshwater and coastal habitat condition	Number km <sup>2</sup>	Aggregated per MS/third country and habitat types listed in Annex I of the Proposal for a regulation on nature restoration.  <i>Based on Natura 2000 / EUNIS data</i> <i>Referring to target 2: nature restoration</i>
Water bodies restored to good ecological status under the WFD	Number km <sup>2</sup>	Aggregated per MS/third country and RBD.  <i>Based on WFD / WISE-Marine data</i> <i>Referring to target 2: nature restoration</i>
Reduction in interruptions of river continuity for fish migration	Number	Change in number of interruptions  <i>Data source: ICPDR</i> <i>Referring to target 1: free-flowing rivers</i>
Improvements in connectivity of habitats, including longitudinal, lateral, vertical and temporal river connectivity	km	Aggregated per country, RBD; and habitat types listed in Annex I of the Proposal for a regulation on nature restoration. <i>Indicator needs to be developed – a common definition needed.</i> <i>Referring to target 1: free-flowing rivers</i>

Here listed indicators could be, by each NBS in the line with EcoDaLLi project, used in a group general or core ones.

## 5.2 OTHER EC PUBLICATIONS

In the European Commission publication **Dumitru and Wendling (eds.)** (2021b), as previously mentioned, lists of recommended and additional indicators for challenge areas are presented, chapter 3.2.3. Additionally, a list for Biodiversity Enhancement is presented. Citation from this publication:

*“The integrated NBS assessment framework presented in the handbook has been developed with the three-fold objective of:*

- *Serving as a reference for relevant EU policies and activities;*
- *Orienting urban practitioners in developing robust impact evaluation frameworks for nature-based solutions at different scales; and,*
- *Providing a comprehensive set of indicators and methodologies.”*

Related to the indicators is stated the following, citation:

*“Each of these indicators has been developed using **SMART** (Specific, Measurable, Attributable, Realistic, and Time-bound) criteria, and each refers to the assessment of particular outcomes. Process indicators are also included, which refer to the characteristics of the NBS implementation process (e.g., number of stakeholders involved in the initial NBS design stage).”*

In the following tables relevant challenge areas for EcoDaLLi are presented, as well as recommended indicators. At the end, several additional indicators are listed.

Tab. 5.1 Indicators related to Water Management classified as structural (S), process focused (P) or outcome-based (O) indicators and their general applicability to different types of NBS

No.	Indicator	Units	Class	Applicability to NBS <sup>†</sup>		
				Type 1	Type 2	Type 3
<b>RECOMMENDED</b>						
3.1	Surface runoff in relation to precipitation quantity	mm/%	O	●	●	●
3.2	Water quality: general urban	various	O	●	●	●
3.3	Water quality: TSS content	mg/L	O	●	●	●
3.4	Nitrogen and phosphorus concentration or load	%	O	●	●	●

3.5	Metal concentration or load	%	O	●	●	●
3.6	Water quality: total faecal coliform bacteria content of NBS effluents	No.	O	●	●	●

**†Type 1 NBS** – minimal or no intervention in ecosystems, with objectives related to maintaining or improving delivery of ecosystem services within and beyond the protected ecosystems

**Type 2 NBS** – extensive or intensive management approaches seeking to develop sustainable, multifunctional ecosystems and landscapes in order to improve delivery of ecosystem services relative to conventional interventions

**Type 3 NBS** – characterised by highly intensive ecosystem management or creation of new ecosystems

Additional 47 indicators are listed as well.

Tab. 5.2 Indicators related to Participatory Planning and Governance

No.	Indicator	Units	Class	Applicability to NBS <sup>†</sup>		
				Type 1	Type 2	Type 3
<b>RECOMMENDED</b>						
17.1	Openness of participatory processes	Number (1-5)	P	●	●	●
17.1.1	Proportion of citizens involved in participatory processes	%	P	●	●	●
17.2	Sense of empowerment: perceived control and influence over decision-making		O	●	●	●
17.3	Adoption of new forms of participatory governance: PPPs activated	No.	O	●	●	●
17.4	Policy learning for mainstreaming NBS: Number of new policies instituted	No.	S	●	●	●
17.5	Trust in decision-making procedure and decision-makers	Number (1-5)	O	●	●	●

Additional 21 indicator listed as well.

Tab. 5.3 Indicators related to Health and Wellbeing

No.	Indicator	Units	Class	Applicability to NBS <sup>†</sup>		
				Type 1	Type 2	Type 3
<b>RECOMMENDED</b>						
21.1	Level of outdoor physical activity		O	●		●
21.2	Level of chronic stress (perceived stress)	Number (0-4)	O	●	●	●
21.3	General wellbeing and happiness	Number (0-7)	O	●	●	●
21.4	Self-reported mental health and wellbeing	Number (1-6)	O	●	●	●
21.5	Prevalence of cardiovascular disease	%	O	●		●
21.5	Incidence of cardiovascular disease	% per year	O	●		●
21.6	Quality of life	Number (1-5)	O	●	●	●

Additional 33 indicators are listed as well.

Tab. 5.4 Indicators related to the New Economic Opportunities and Green Jobs

No.	Indicator	Units	Class	Applicability to NBS <sup>†</sup>		
				Type 1	Type 2	Type 3
<b>RECOMMENDED</b>						
23.1.1	Valuation of NBS: Value of NBS calculated using GI-Val	€	O	•	•	•
23.1.2	Economic value of urban nature	€	O	•	•	•
23.2	Mean land and/ or property value in proximity to green space	€	O	•		•
23.2.1	Change in mean house prices/ rental markets	€	O	•		•
23.2.2	Average land productivity and profitability	€/ha	O	•	•	•
23.2.3	Property betterment and visual amenity enhancement	€/m <sup>2</sup>	O	•		•
23.3	Direct economic activity: Number of new jobs created	€/year	O	•	•	•
23.4	Direct economic activity: Retail and commercial activity in proximity to green space	%	O	•		•
23.5	Direct economic activity: Gross value added to local economy from new business creation	%/year	O	•	•	•
23.6	Recreational monetary value	€/year	O	•		•
23.7	Overall economic, social and health well-being	Human Development Index	O	•	•	•

Additional 36 indicators are listed as well.

In the publication **Dumitru and Wendling (eds.)** (2021a) a comprehensive review of all indicators significant for urban areas is given. This is probably the best current source for future developers of NBS. Methods for assessment and appraisal of all indicators listed in previous publications are presented. One example which follows, cited part of this.

### 10.19 Species diversity – general

Species diversity - general		Biodiversity
<b>Description and justification</b>	<p>It is important to foster research and monitoring of biodiversity to determine the best assemblages of species to achieve the most efficient NBS, including the optimization of multiple economic, ecological and social benefits and exploration of trade-offs created by NBS. This can be achieved by collection of new data in the field and the use of remote sensing to gather comprehensive data on additional benefits, to complement existing data and observation.</p> <p>Species diversity refers to the number of individual species per area. It can be useful in detecting colonisation of a given area or response of species to a given management action. Counts for species or groups of species can provide an intuitive biodiversity metric which also has public resonance and the data can be used to populate indicators and measure progress towards conservation policy targets. Whilst survey of individual target conservation species and/or umbrella species can be of value in relation to specific conservation objectives, quantification of biodiversity indices can also have value in providing a more holistic insight into overall biodiversity and greater representation of a range of taxa.</p>	
	<p>Key drivers for such biodiversity monitoring include:</p> <ul style="list-style-type: none"> <li>- Assisting local authorities to evaluate their progress in urban biodiversity conservation (for example against Aichi/national/local biodiversity targets);</li> <li>- Ensuring NBS contribute positively to biodiversity conservation;</li> <li>- Creating a foundation for development of Local Biodiversity Strategies/Action Plans (see example of Lisbon, Portugal in MAES reference below)</li> </ul> <p>Serving as a public platform upon which biodiversity awareness raising exercises can be launched.</p>	
<b>Definition</b>	Changes in overall number of species/species diversity/biodiversity indices within area affected by NBS.	

<p><b>Strengths and weaknesses</b></p>	<p>+ Count of species is relatively easy to monitor</p> <p>- Sensitive to area and site specific – extrapolation to larger area overestimates species density due to the non-even species distribution. Mobile species counts require taking into consideration their different relation to the studied habitat/area (e.g., migrants, breeding – resting species).</p> <p><b>Applied methods:</b> Strength of indicator depends of the quality of the data used and the representativeness of the index selected to overall biodiversity patterns. Raw data can characterise species spatial and temporal distributions but are generally limited because of the time/costs involved in the detailed level of data collection needed to accurately detect change.</p>
	<p><b>Earth observation/Remote sensing methods:</b> Remote sensing has been increasingly contributing to timely, accurate, and cost-effective assessment of biodiversity-related characteristics and functions during the last years. Various studies have demonstrated how satellite remote sensing can be used to infer species richness. However, most relevant studies constitute individual research efforts, rarely related with the extraction of widely adopted Convention on Biological Diversity (CBD) biodiversity indicators (Petrou et al., 2015). Furthermore, systematic operational use of remote sensing data by managing authorities remains limited. The monitoring with CBD related indicators can be facilitated by remote sensing. Numerous studies using RS data to measure biodiversity-related properties are presented in the literature, covering a broad range of applications, study areas, data and methods. However, most studies are rarely explicitly connected to any widely adopted biodiversity indicator that could be extracted through them directly or indirectly. Instead, various indicators have been used by individual studies, resulting in numerous incompatible monitoring systems (Feld et al. 2009). Furthermore, despite the increasing availability of RS data, the connection between variables measured by RS and indicators required by the biodiversity and policy-making community is still poor (Secades et al. 2014). Thus, a link of RS approaches to a common set of indicators would be highly beneficial.</p>
<p><b>Measurement procedure and tool</b></p>	<p>A variety of methods exist from applied/public participation techniques through to earth observation/remote sensing approaches.</p>

**Applied/Participatory Methods:**

Use species or groups of species count methods (e.g., plot (quadrat) count, point count and line transect methods) to calculate species density expressed in units of species per specified area.

The City Biodiversity Index (CBI) (Chan et al 2014), was proposed to engage cities in the implementation of the Convention on Biodiversity's strategic plan for biodiversity. The CBI was intended to provide a benchmark of biodiversity conservation efforts of cities, it provides a self-assessment tool to monitor the progress of biodiversity conservation efforts against a city's baseline.

### 5.3 JOINT RESEARCH CENTRE

In the publication **Maes, et al.** (2020) numerous fact sheets, i.e., indicators are presented. However, these are primarily aimed at collecting data used to follow development of environmental interesting facts for whole EU related to policies. In despite of this, the material can be used for justifying selected measures, and some of indicators may be apply for NBS projects/interventions. Selected fact sheets which can be relevant for the EcoDaLLi project are listed below.

**Fact sheet 3.4.101: Change of area due conversion (wetlands)**

General information

- Thematic ecosystem assessment: Inland marshes and peatbogs
- Indicator class: Habitat conversion and degradation (Land conversion)
- Name of the indicator: Change of area due to conversion
- Units: %/6 years.

**Fact sheet 3.4.201: Wetland connectivity**

General information

- Thematic ecosystem assessment: Inland marshes and peatbogs
- Indicator class: Ecosystem condition – Structural ecosystem attributes (general)
- Name of the indicator: Wetland connectivity
- Units: km.

**Fact sheet 3.4.202: Percentage of wetlands covered by Natura 2000**

General information

- Thematic ecosystem assessment: Wetlands (Inland marshes and peatbogs)
- Indicator class: Condition. Structural ecosystem attributes monitored under the EU Nature Directive

- Name of the indicator: Percentage of inland marshes and peatbogs covered by Natura 2000 (%)
- Units: percentage (%).

#### **Fact sheet 3.5.203: Article 17 habitat conservation status**

##### General information

- Thematic ecosystem assessment: all
- Indicator class: Conservation status and Structural ecosystem attributes monitored under the EU
- nature directives
- Name of the indicator: Conservation status and trends per habitat group
- Units: %.

#### **Fact sheet 3.6.202a: Water quality in rivers**

##### General information

- Freshwater ecosystems
- Environmental quality
- Water quality in rivers
- River concentration data on BOD5, ammonium, nitrate and phosphate.

#### **Fact sheet 3.6.206a: Land cover in riparian areas**

##### General information

- Freshwater ecosystems
- Condition: Environmental quality
- Land cover share in riparian areas (artificial areas, agricultural areas, natural areas)
- %.

#### **Fact sheet 3.6.206b: Hydromorphological alteration (density of infrastructures in riparian areas)**

##### General information

- Freshwater ecosystems
- Environmental quality
- Hydromorphological alteration by infrastructures in riparian/floodplain areas
- km of infrastructure/km<sup>2</sup> of riparian-floodplain areas.

#### **Fact sheet 3.7.110: Number of newly introduced non-indigenous species**

##### General information

- Thematic ecosystem assessment: Marine ecosystems
- Indicator class: Pressures/Introduction of invasive alien species

- Name of the indicator: Number of newly introduced non-indigenous species (number/year)
- Units: number of species.

#### **Fact sheet 4.2.101: Pressure by Invasive Alien Species on terrestrial ecosystems**

##### General information

The pressure by Invasive Alien Species (IAS) is a spatially explicit crosscutting indicator that can contribute to assessing the pressures acting on ecosystems.

The indicator quantifies the cumulative and relative pressure by IAS on each terrestrial ecosystem type, using a unitless figure directly related to the relative extent of each ecosystem type negatively affected, over a reference grid of 10 km spatial resolution.

- (Thematic ecosystem assessment): Common indicators for pressures and ecosystem condition
- Indicator class:
  - Pressure class: Invasive alien species;
  - Condition class: Environmental quality
- Name of the indicator: Pressure by Invasive Alien Species on terrestrial ecosystems
- Units: unitless [between 0 and the number of IAS recorded in one area].

#### **Fact sheet 4.2.102: Pressure by Invasive Alien Species on freshwater ecosystems**

##### General information

The pressure by Invasive Alien Species (IAS) is a spatially explicit crosscutting indicator that can contribute to assessing the pressures acting on ecosystems.

The indicator quantifies the cumulative pressure by IAS on freshwater ecosystems, using a unitless figure directly related to the relative extent of freshwater negatively affected, over a reference grid of 10 km spatial resolution.

- (Thematic ecosystem assessment): Common indicators for pressures and ecosystem condition
- Indicator class:
  - Pressure class: Invasive alien species
  - Condition class: Environmental quality
- Name of the indicator: Pressure by Invasive Alien Species on freshwater ecosystems
- Units: unitless [between 0 and the number of IAS recorded in one area].

#### **Fact sheet 5.0.500: Ecosystem service: flood control**

##### General information

- Regulating and maintenance ecosystem service (CICES V.5.1);
- Flood control: regulation of water flow (runoff) by ecosystems that mitigates or prevents

- Potential damage to land assets (i.e., infrastructure, agriculture) and human lives. The current
- Assessment covers only riverine floods for artificial surfaces (i.e. urban MAES ecosystems);
- Components assessed for flood control:
  - Potential: dimensionless indicator of potential runoff retention (between 0 and 100)
  - Demand: extent of artificial surfaces (in km<sup>2</sup>) located in floodplains (for a return period of 500 years)
  - Use: extent of the demand (artificial areas) protected by upstream ecosystems (in km<sup>2</sup>)
  - Unmet demand: extent of the demand not protected by upstream ecosystems (in km<sup>2</sup>).

## 5.4 ICPDR

On the web site of this highly relevant institution publications useful for the selection of indicators and data can be found. Only one example is **Liška, et al.** (2021) with comprehensive sets of data about the status (quality and pollution) of the Danube and its tributaries water and water bodies, as well as fishes.

A special chapter is related to the pollution with plastic, **Occurrence of microplastics in the Danube River – A first screening**. For a more comprehensive assessment of the Danube regarding plastic (nano to macro- plastic), a more extensive project is needed.

## 5.5 CONNECTING NATURE

The project *Connecting Nature*, <https://connectingnature.eu/>, produced significant publications related to NBS and issues of its impacts. These could be useful for future implementers of NBS.

In **Dumitru and Lourido** (2020), *Powerful evidence for nature-based solutions: identifying opportunities for NBS impact assessment. Connecting Nature*, interesting approaches to the application of indicators are presented. The following is a citation:

*“As a final result from a co-creation process with cities, 108 indicators were grouped into 5 impact categories:*

1. *Environmental (Env)*
2. *Health and Wellbeing (HW)*
3. *Social cohesion (SC)*
4. *Economic (ECO)*
5. *Participatory Planning and Governance (PPG)”*

In the same publication impact assessment gaps for cities are listed:

1. Lack of theory of change: assessing indicators possibly related to the NBS without previously reflecting on the expected impact.
2. No selection of indicators for the city due to an initial assessment of resources.
3. Suitability of some indicators to measure the NBS impacts depending on the scale and the existing methodology.
4. Lack of available data to establish a baseline.
5. Contact with public administrations or people who have data of interest.
6. Internal capacity in cities to collect and analyse data or represent the results in a spatial dashboard.

Number of core (C) and feature (F) indicators per impact category are presented in Fig. 5.1.

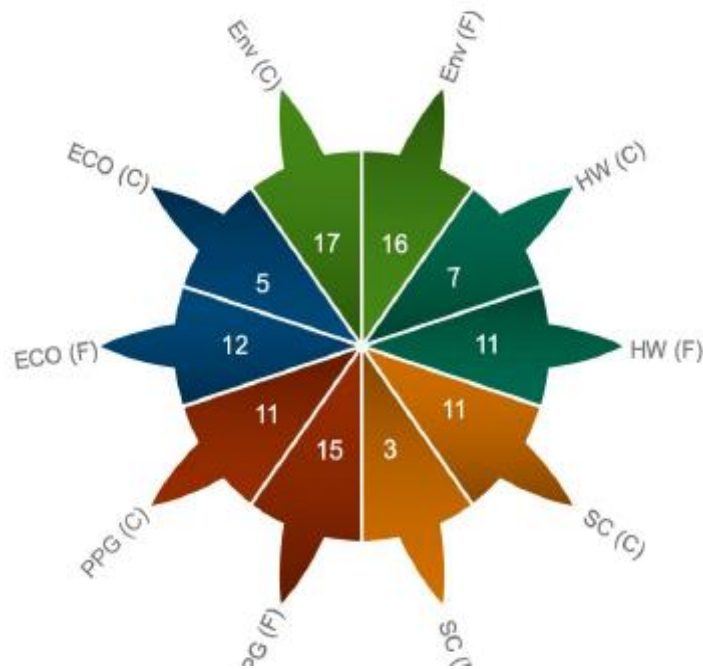


Fig. 5.1 Number of used indicators per categories

In **Connop (ed.)** (2020), (publication is WP report of project Connecting Nature) a list of indicators of EU finalized or ongoing NBS projects, general and relevant to urban areas, are presented, citation, in Tab. 5.5.

Tab. 5.5 Full list of Environmental Indicators for Nature-based Solutions (highlighted these which could be interesting for EcoDaLLi)

- |  |  |
|--|--|
| 1. Carbon storage OR Carbon sequestration in vegetation/soil                     | 47. Access to vehicle sharing  |
| 2. Carbon sequestration rate by tree species                                     | 48. Access to public amenities   |
| 3. Air temperature change  | 49. Length of bike route network   |
| 4. CO <sub>2</sub> emissions reduced   | 50. Land devoted to roads  |
| 5. Energy savings  | 51. Road density   |
| 6. Climate resilience strategy   | 52. Leapfrog development index   |
| 7. Albedo  | 53. Linearity development index  |
| 8. Rainfall storage/absorption capacity of NBS                                   | 54. Area for pedestrians   |
| 9. Flood peak reduction/delay  | 55. Green space area   |
| 10. Reduction of drought risk  | 56. Blue space area  |
| 11. Increase groundwater availability  | 57. Population density   |
| 12. Groundwater quality  | 58. Local food production  |
| 13. Water exploitation index   | 59. Cultivated crops   |
| 14. Drinking water (surface/ground)  | 60. Urban sprawl   |
| 15. Water quality  | 61. Intensity of land use  |
| 16. Increase evapotranspiration  | 62. Land-use intensity   |
| 17. Air Temperature – Energy demand  | 63. Landuse mix  |
| 18. Reduction of stormwater treated in public sewerage system (economic benefit) | 64. Brownfield use   |
| 19. Inundation risk for critical urban infrastructures(probability-economic)     | 65. Annual amount of pollutants captured by vegetation                     |
| 20. Flood damage (economic)  | 66. Air quality change   |
| 21. Water consumption  | 67. Share of emissions (air pollutants) captured/sequestered by vegetation |
| 22. Increase greywater and rainwater reuse                                       | 68. Pollutant fluxes per m <sup>2</sup> per year                           |
| 23. Public green space distribution  | 69. Value of air pollution reduction                                       |
| 24. Recreational value of blue-green spaces                                      | 70. Total monetary value of urban forests                                  |
| 25. Cultural value of blue-green spaces  | 71. Atmospheric pollutant flux   |
| 26. Community accessibility  | 72. NO <sub>x</sub> emissions  |
| 27. Connectivity of urban green and blue spaces (structural and functional)      | 73. Fine particulate matter emissions                                      |
| 28. Ecological connectivity (general)  | 74. Air quality index  |
| 29. Supporting/increasing biodiversity conservation                              | 75. Noise mitigation by vegetation   |
| 30. Increase in pollinators (habitat)  | 76. Increase portion of sky visible from the ground                        |
| 31. Increase in pollinators (abundance of pollinators)                           | 77. Index of habitat types   |
| 32. Urban forest pattern   | 78. Targeted habitats  |
| 33. Urban tree health  | 79. Proportion of landscape not in intensive management                    |
| 34. Number of native species   | 80. Reduction in pesticide use   |
| 35. Species diversity  | 81. Soil sealing   |
| 36. Species under nature conservation designation                                | 82. O <sub>2</sub> production by vegetation                                |
| 37. Introductions  | 83. Light levels at night  |
| 38. Mapping ecosystem services and spatial-temporal biodiversity legacies        | 84. Noise pollution reduction  |
| 39. Ecological connectivity (Ecological connectivity Index)                      | 85. Change in ecosystem service provision                                  |
| 40. Fragmentation  | 86. Temperature increase/wind shelter                                      |
| 41. Accessibility of greenspaces   | 87. Use of organic fertilizers   |
| 42. Land-use change and greenspace configuration                                 | 88. Tree shade for local heat change                                       |
| 43. Ratio of open spaces to built form   | 89. Community garden area per capita and in a defined distance             |
| 44. Reclamation of contaminated land   | 90. Community garden area per child capita and in a defined distance       |
| 45. Citizen access to public transport   | 91. % of protected areas (ecologically and/or culturally sensitive)        |
| 46. Quality of public transport  | 92. % of buildings with NBS adaptation                                     |
|  | 93. Habitats restored  |

In the Tab. 5.6 Environmental Core indicator are listed, 17 in total as presented in Fig. 5.1.

Tab. 5.6 Indicators identified as Core during the co-produced scoping process (highlighted are those which could be interesting for EcoDaLLi)

- Air temperature change (Env03)
- Rainfall storage (water absorption capacity of NBS) (Env08)
- Flood peak reduction/delay (Env09)
- Water quality (Env15)
- Inundation risk for critical urban infrastructures (probability) (Env19)
- Public green space distribution (Env23)
- Recreational value of blue-green spaces (Env24)
- Cultural value of blue-green spaces (Env25)
- Connectivity of urban green and blue spaces (structural and functional) (Env27)
- Supporting/increasing biodiversity conservation (Env29)
- Species diversity (Env35)
- Land use change and greenspace configuration (Env42)
- Access to public amenities (Env48)
- Blue space area (Env56)
- Soil sealing (Env81)
- Change in ecosystem service provision (Env85)
- Community garden area per capita and in a defined distance (Env89)

Within the project numerous indicators presented in **Dumitru and Wendling (eds.) (2021a)** are defined. Here the description of Connectivity Indicator, Env27, is presented (partly reduced).

**“Connectivity of urban green and blue spaces (structural and functional), Env 27**

**Indicator:** Connectivity of urban green and blue spaces (structural and functional)

**Description:** A more applied and participatory focus to measuring the potential for green or blue areas to amplify the connectivity and multifunctionality of other urban green/blue areas.

**Metric(s):** Connectivity of landscapes can be evaluated in terms of:

- Structural connectivity – relating to the spatial configuration of patches, without considering the movement of individual organisms among these patches (**Ioja et al. 2014**) and
- Functional connectivity – relating to the ability of organisms to move among patches (**Tischendorf and Fahrig, 2000**).

Both types of connectivity can be quantified using metrics that span different ranges of scale and complexity.

**Scientific solid evidence:** Robustness of evidence for structural connectivity tends to be based on...

**Level of expertise:** Expertise in mapping and interrogation of data using GIS software is typically required.

**Effort:** Effort is generally associated with the scale of spatial analysis and the data input requirements. Once data is inputted, data analysis can be relatively low effort. Keeping databases updated can require additional effort.

**Participatory process:** Opportunities are available for participation. This can be in the form of mapping green spaces using internet-based public participation GIS (PPGIS), assessing habitat...

**Data availability:** Aerial photography data is widely available, although resolution of open access data can represent a barrier depending on the scale of investigation...

**Geographical scale:** Analysis is generally performed on a city-wide or regional scale. Local connectivity analysis is also possible.

**Temporal scale:** Evaluation methods can be adopted for short-term snapshots associated with a change in land use, or strategic connectivity planning. Production of strategic maps can, however, represent a baseline for long-term evaluation of change in connectivity.

**Synergies:** Strong synergies exist with any indicators that require blue-green space mapping as the foundation for analysis.

**Earth observation/remote sensing/modelling:** Spatial modelling forms the foundation of this indicator. For earth observation, remote sensing and/or

*modelling approaches, including those used on past and current EU projects, see: Env27\_RS.*

**Original reference(s) for indicator: Raymond et al., 2017; Ioja et al., 2014**

**Metric reference(s): given the long list of references.”**

This is a good example of indicator presentation. The number of characteristics could be reduced to a lower number. Obligatory: description, metric(s), level of needed expertise or, simpler, applying RACER or/and SMART approaches.

## COMMENTS

The selection of plausible indicators is crucial for the success of NBS projects. This chapter lists various types of indicators, with a focus on those most significant for EcoDaLLi, practitioners, and NBS developers. The importance of Key Performance Indicators (KPIs) is emphasized throughout (see Tb. 5.1).

The principles for indicator selection, namely RACER and SMART, are described in detail. A key aspect of this deliverable is the intention to minimize costs without compromising quality. This is particularly important for frequent evaluations and measurements during the operational phase, where engaging citizens and volunteers is encouraged whenever possible. Measurement and evaluation of indicator values can often be expensive; therefore, less complex and costly indicators should be chosen for more frequent assessments, ideally ones that can be performed by trained individuals. Moreover, selecting indicators based on RACER and SMART principles can reduce both effort and costs, thereby preventing misleading results.

The targets and indicators for the Mission and Danube Lighthouse, including Impact, Output, and Outcome indicators presented by Alao Chanou et al. (2023), are discussed here in a manner that is easier for practitioners to understand and apply. These indicators can be effectively implemented by appropriately defined and selected KPIs for each specific NBS restoration project.

Overall, the importance of identifying best practices in biodiversity conservation and restoration is highlighted, particularly regarding the relevant indicators for biodiversity enhancement that are essential for NBS practitioners (see Tab. 5.5).

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## 6. METHODOLOGY FOR NBS PROJECT/INTERVENTION

To effectively assess a Mission-relevant NBS project concerning biodiversity conservation and restoration, it is essential to follow the Methodology-Flowchart presented in this chapter. This ensures that the project adheres to the necessary steps and key features outlined in previous chapters. By doing so, practitioners can verify that their project aligns with the principles and requirements critical for the successful implementation of Nature-Based Solutions (NBS).

In the title of this chapter, the term project/intervention, (practiced by IUCN) is used. This doubling of the name might appear unnecessary but especially in the case of small-scale projects the word intervention seems more proper than project. In the following, the term NBS project will be used.

Generally, NBS projects can be local, regional, national, multinational, macro-regional, small, and large-scale. The presented methodology is basic, but, with adequate modification, can be applied to all types of NBS projects listed.

The Methodology presented here is aiming at helping NBS developers and practitioners but can be helpful for decision-makers and authorities as well. Alongside the previous chapters, this is intended as a guide for project development and implementation. However, every new, not simply copied, or partly replicated project, should start with a study of the newest research and innovative solutions-oriented publications. The RTI activities related to NBS are very intense and therefore the most recent publications should be given priority.

The development of NBS meaning is demonstrated in Chapter 2. There are many definitions and approaches to this. For the tasks defined in the EcoDaLLi project, the following definition, cited from **Raymond et al.** (2017), seems to be the most appropriate, although it does not contain all the elements of NBS:

*“Researchers are now encouraged to move from ecosystem-based approaches to nature-based solutions (NBS) in order to work integratively with ecosystems to adapt to and mitigate the impacts from climate change, conserve biodiversity and improve human health and well-being (Cohen-Shacham et al., 2016).”*

As described in Chapter 3, diverse terms are used in the references. Here the term methodology is used for the procedure of NBS project’s fulfillment, from the idea to the realization, including lifelong maintenance, monitoring and evaluation. The term method(s) is used for indicators, the expression of their function, measured/determined values and use for the effectuation of NBS project realization. The terms framework and approach are used to describe procedures, and techniques, for diverse activities and objectives.

The project scope should include problems and challenges relevant to this definition, adding in participatory planning, governance and economic benefits, to qualify the project for nomination as NBS. The selection of the challenges adequate for EcoDaLLi (some modifications are possible) is presented in Chapter 4.

For verification of the project, the type of engineering intervention is of interest. Priority have green, blue or green-blue solutions. A combination of the previous with classic, grey infrastructure, so-called hybrid solutions, is acceptable if necessary. However, to which extent the percentage of grey may be accepted for NBS, is not clearly defined.

In the same, previously cited publication, stages of project development are presented, citation:

*“The seven stages include: 1) identify problem or opportunity; 2) select and assess NBS and related actions; 3) design NBS implementation processes; 4) implement NBS; 5) frequently engage stakeholders and communicate co-benefits; 6) transfer and upscale NBS; and 7) monitor and evaluate co-benefits across all stages. We conclude that the developed framework together with the seven-stage co-benefit assessment process represent a valuable tool for guiding thinking and identifying the multiple values of NBS implementation.”*

Almost the same seven stage approach is proposed by **Dushkova and Haase (2020)**, see Fig. 3.13, Chapter 3, for knowledge base development.

Further, the authors proposed four information sections, see Fig. 3.14 Chapter 3. Here the section related to Part III is cited:

*“Part III provides information on governance arrangements, including initiators (public, private, public-private, governmental institutions, scientific or technical advisors), key actors and stakeholders (public, private, public-private, governmental institutions, scientific or technical advisors) involved in the planning and implementation of NBS. It also includes financing aspects such as the sources of funding, total cost and types of funding used (also by indication of EU sources).”*

Fig. 6.1 is a graphic presentation of this part.

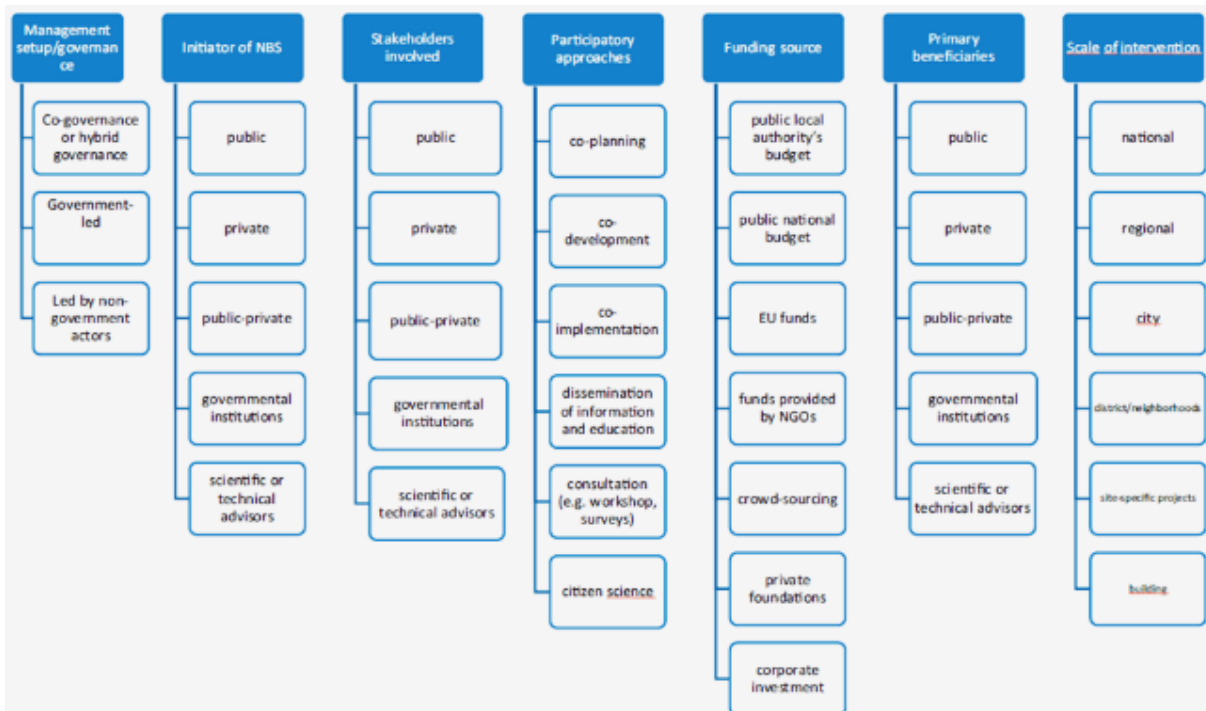


Fig. 6.1 Key characteristics and their variables included Governance and Financing

In a frame of NBS projects, the introduction of protected areas could contribute to the quality of some challenges. In the publication **DANUBEPARKS (2019)** valuable information about barriers, hydropower plants, in seven DRB countries, as well as the issue of protected

areas is presented. Over twelve thousand protected areas, see IUCN classification, are located in the DRB and are in most cases effective as habitats and for ecological connectivity.

- Category Ia – Strict Nature Reserve
- Category Ib – Wilderness Area
- Category II – National Park
- Category III – Natural Monument or Feature
- Category IV – Habitat/Species Management Area
- Category V – Protected Landscape/Seascape/Area
- Category VI – PA with sustainable use of natural resources

Cited from this publication: “*The Danube Delta includes a large area, most of which are IUCN Category V*”. Existing and future protected areas could contribute to Health and well-being as well as New Economic Opportunities and Green Jobs.

Some further publications which elaborate on issues very close to those mentioned in EcoDaLLi WP2 and Task 2.1. are discussed here. In **Anonymous** (2022) the removal of barriers on the Danube River is elaborated e.g. in Chapter 3. *Guidance on site selection for barrier removal* and Subchapter 3.2 *Improving longitudinal and lateral connectivity making use of available knowledge and tools for prioritization*. For the economic issues Chapter 4. *EU financing instruments – An overview* is of interest.

A few specific EcoDaLLi relevant objectives (within the challenge area Water Restorations), are presented in Fig. 6.2, excerpt from the publication **Albert et al.** (2019).



Fig. 6.2 Specific EcoDaLLi project objectives within the challenge area Water Management

In the EC project **Wild** (2020) in Chapter 5, *the evidence base on NBS and their relative cost-effectiveness* and Subchapter 6. *Business models and financing of NBS for water management* are elaborated. These chapters provide a useful basis for elaboration on the sensitive issues of economic benefits.

Interesting ideas for NBS developers, as well as new approaches related to floodplains and wetlands restorations, could be induced in the following publications: **Strosser et al.** (2015), **Funk et al.** (2019), **Anonymous** (2013) and **Anonymous** (2018).

Another useful resource is the publication **Gregg et al.** (2022), that was already mentioned in Chapter 4.3, Fig. 4.5. This publication elaborates on participatory issues, and is proposed to be used by participators of NBS. Below, descriptions of stakeholders' equitable engagement are cited once again:

*“**Stage 1** covers the importance of understanding contexts, including local norms, cultures, standards and regulations, and provides practical means for doing so through various mapping and engagement steps.*

*In **Stage 2**, the project team identifies levels of stakeholder engagement and proposes the development of a stakeholder engagement plan to guide all participation and communications in further stages of a project.*

***Stage 3** outlines methods for involving stakeholders throughout all aspects of the design stage of an NBS project, emphasizing co-creation with diverse stakeholders. In this stage, stakeholders will be assigned roles and responsibilities, collaborate on project design and aid in finalizing the design plan.*

***Stage 4** identifies how to engage with stakeholders throughout the implementation phase, how to maintain transparent, two-way communications and how to ensure equitable participation in project launch.*

*In **Stage 5**, the project team proposes the development of a monitoring and evaluation plan, which may involve stakeholders in data gathering and analysis, and suggests means for open communication with stakeholders regarding updates and receiving feedback.”*

One additional example is the question: What are stakeholders interested in:

- *“What are the major challenges faced by the organization investing in an NBS project?*
- *What are the major challenges faced by the individuals and communities outside of the project location?*
- *What are the major challenges existing outside of the project location that may impact the project, the organization investing in an NBS project, and individuals and communities?*
- *What are the objectives of an NBS project?*
- *What are the possible stacked or accumulative benefits that could accrue from this NBS project? And who benefits from these stacked benefits?*
- *Where are the proposed NBS interventions taking place? Are there strategic areas for NBS project implementation?*
- *Who else is investing in or implementing NBS projects in the watershed?”*

As a methodological issue, the author proposed the creation of a checklist for stakeholders' engagement and obtained results. All the above mentioned information was used as basis for the proposed methodology.

In the publication **Veerkamp et al. (2021)** in *Annex 3 - Interview guide: deployment of assessments in NBS projects for CCA/DRR*, an usable approach to NBS configuration is demonstrated, especially for Disaster Risk Reduction and Management. In the same publication an excerpt, Tab. 6.1, on limits and success factors is presented. This can help NBS developers as well.

Tab. 6.1 The success and limiting factors of nature-based solutions in adaptation and disaster risk management (list of used references for this table is available in publication)

Limiting factors of NBS	Success factors for NBS
Lack of political support.	Supporting plans, acts and legislation. Policy mechanisms are available to address gaps and encourage uptake.
Poor stakeholder engagement and attitudes.	Positive stakeholder engagement and attitudes.
Social and cultural constraints due e.g., cultural preferences for certain aesthetics (what a landscape should look like), risk perceptions relating to different management practices and sense of ownership and place.	Participatory approaches engaging a range of stakeholders, which may include awareness building, giving a voice and co-creation and/or co-management.
Physical and biological constraints due to e.g., degraded ecosystems as a starting point for NBS intervention.	Availability of existing healthy ecosystems or ability to improve degraded ones.
Lack of land or space constraints for implementation.	Adequate scale of implementation and cooperation across landowners. Incentives to encourage cooperation.
Lack of cooperation and consent across landowners and agencies.	Alignment of activities across agencies including shared institutional structures. The use of trusted agents and stakeholder engagement throughout planning and implementation.
Incomplete demonstration of own or comparative benefits (e.g., knowledge gaps on limits and thresholds under which NBS approaches might not deliver adaptation benefits) and unclear cost effectiveness.	Demonstration of multiple co-benefits including multiple ecosystem services. Demonstration of cost effectiveness in comparison to alternatives, including for successful integration with grey infrastructure with demonstrable benefits and leading to optimal planning and design.
Demonstration of effectiveness not tailored to purposes or not at an appropriate scale (e.g., water runoff reduction only demonstrated at plot level but not at catchment scale) and imbalance of knowledge sources underpinning assessments.	Demonstration of effectiveness for the purpose at adequate scale, including adequate monitoring mechanisms.
Gap of knowledge between private benefits to individual entities and broader social costs and benefits for communities. Time lags in achieving and observing benefits.	Demonstration of both private and social costs and benefits over short- and long-term.
Evidence is context specific and often not transferable and is not shared.	Existing knowledge and/or ongoing research and monitoring with common indicators and innovation and demonstration projects (incl. reporting standards). Established knowledge sharing mechanisms, education and training.
Lack of finance for implementation of NBS (e.g., for land acquisition/compensation) and maintenance.	Availability of finance. Multiple sources of finance linked to multiple benefits and multiple ecosystem services. Early budgeting and assignment of funds and responsibilities to meet maintenance needs.
Difficulties in NBS tendering process (e.g. lack of knowledge on how to present a convincing business case for NBS, lack of track record, lack of (experienced) suppliers, path dependency favouring engineered solutions).	Engagement with NBS technical and NBS economics experts to gather supporting evidence for robust business case development. Early cross-departmental collaboration including engaging with procurement and finance units. Consideration of alternative procurement and delivery mechanisms outside own procurement.

## 6.1 METHODOLOGY FRAMEWORK

The presented methodology is designed for developers of NBS projects and interventions that contribute to the realization of Mission Ocean and Waters targets, among others. This document serves as a guide, manual, or toolbox for practitioners, offering a comprehensive yet easily understandable and applicable framework. In addition to practitioners, it can also benefit decision-makers and authorities by addressing the necessary administrative procedures and documentation. Several operational bodies, such as Governance Team (GT), Stakeholders Group (SG) and Experts Working Group (EWG), have been proposed.

The methodology outlines the complete process of NBS project development and implementation, from the initial idea through to the operational phase. This comprehensive approach is a notable distinction, as similar frameworks have not been identified in the reviewed literature. A key innovation of the methodology is its focus on reducing costs and working time associated with NBS development, which is achieved through the introduction of several decision points.

The proposed methodology is a living document which was prepared by engaging all the partners within the EcoDaLLi project but will be further tested throughout the duration of the project, upgraded and modified whenever it is found to be useful and beneficial. The presented methodology is generalized and orientational. It could be used for diverse project types and complexity of intervention. For the project realization many other common and specific activities, not presented here, are needed. The methodology is primarily targeted towards obtaining NBS features of the project.

The project realization consists of three phases:

1. Preparatory – NBS Assessment.
2. Restoration.
3. Operational.

### 6.1.1 Preparatory – NBS Assessment and Restoration Phases

#### **Preparatory – NBS Assessment Phase**

This phase consists of three subphases:

- 1.1 Initialization and pre assessment.
- 1.2 Validation – assessment of NBS feature.
- 1.3 Project design.

**Subphase 1.1.** begins with the identification of the problem(s), definition of the vision(s) for solution(s), enhancements, restoration, etc. This is performed by initiator, developer, of the potential project, with moderate engagement, outsourcing, of experts. Already in this phase are involved, on voluntary basis, some relevant stakeholders. They develop conceptual design and prefeasibility study. It is important to have at least basic knowledge about NBS. Performing preliminary financial appraisal is obligatory. Final of this phase is evaluation of initiative, decision point **D1** (in following methodology framework, related to D2 and D3 as well). If the evaluation is negative, further activities could be canceled, or some modification, improvements performed.

The termination of project can be caused by diverse reasons: Problems of legality, ownership, public dissatisfaction with proposed restoration, doubts about restoration results, engineering difficulties, etc. Up to this this point, only minor investments of funds and labor are made. In subchapter 4.3 it is mentioned that one of the important possible economic benefits of NBS projects can be a reduction of costs in this phase. Especially in this stage of the first phase, the Project Core Team can achieve a lot by using this publication, and consulting additional experts.

In the case of positive evaluation results the process will be continued.

**Subphase 1.2** will be continued with deeper development of the project. For the following activities is needed engagement of diverse experts. They, together with initiator and other stakeholders, elaborate detailed evaluation of the project, with engagement of experts groups and wider stakeholders.

For initial assessment of the current situation and the values of selected indicators, the term **Baseline Data Collection** is used. For the project effects' the term **Theory of Change**, describing the vision or hypothesis of the project is used. Among other things, desirable, targeted, values of selected indicators, that should be obtained after predetermined periods are defined here.

An example of Theory of Change is provided in **Dumitru and Wendling, (eds.)** (2021b), and presented in Fig. 6.3. Citation:

*“A theory of change is a description of how an intervention is intended to deliver the desired results. It describes the causal logic of how and why a particular program or intervention will reach its intended outcomes. A theory of change is a key underpinning of any impact evaluation, given the cause-and-effect focus of the research (Gertler et al., 2016, p. 32).”*



Fig. 6.3 Example of the Theory of Change (simplified adapted from The Young Foundation, CLEVER Cities project - D4.3/ WP4)

In the Theory of Change, challenge areas and relevant objectives are defined. Proper selection of functional and general challenge areas and objectives is an important segment for project validation as NBS.

During this phase the **Monitoring and evaluation** Plan for the Operational phase will be developed, that is relevant for the procedure and methods of data collection and processing.

This phase is finalized by confirmation, verification, validation that the planned project is featured as NBS. This is decision **D2**. If the decision is negative, still one or more restructuring could be undertaken. In the case of positive result, activities will be continued.

**Subphase 1.3** comprises additional activities, mostly related to NBS projects. For example, it is possible that restoration can be performed only as grey infrastructure. If this is



the case, or other, not previously defined obstacles arise, further activities will terminate. Also, here are performed activities relevant to participatory planning and governances. This subphase is finalized with NBS project conceptual design, background for further engineering articulation and realization of restoration phase.

The decision point is **D3**. Negative decision can be result of too high costs, stated after detailed appraisal, negative opinion for some solutions of some stakeholders, eventual juristic problems for realization. It is negative to have project termination on this stage, while the costs are on a high level.

### **Restoration phase**

This phase has a structure commonly used for other engineering-restoration projects. An important difference is the participation of stakeholders in activities relevant to terms of reference, selection performers, and construction monitoring.




## **Methodology Framework**

The methodology framework is presented as a Flowchart. The following symbols are used.

A blue rounded rectangle with a thin black border.

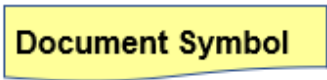
### **Start/Stop Symbol**

The terminator symbol marks the starting or ending point of the system. It usually contains the word "Start" or "End."

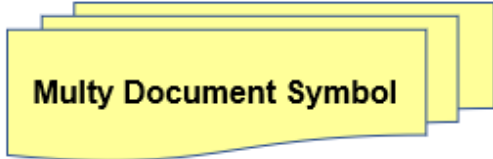
A light blue rectangle with a thin black border.

### **Action or Process Symbol**

A box can represent a single step, or an entire sub-process within a larger process.

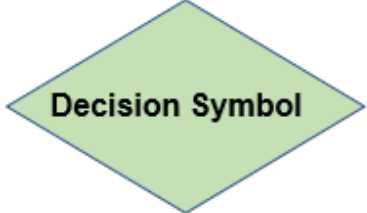
A yellow rectangle with a thin black border.

### **Document Symbol**

A stack of three yellow rectangles with thin black borders, overlapping each other.

### **Multy Document Symbol**

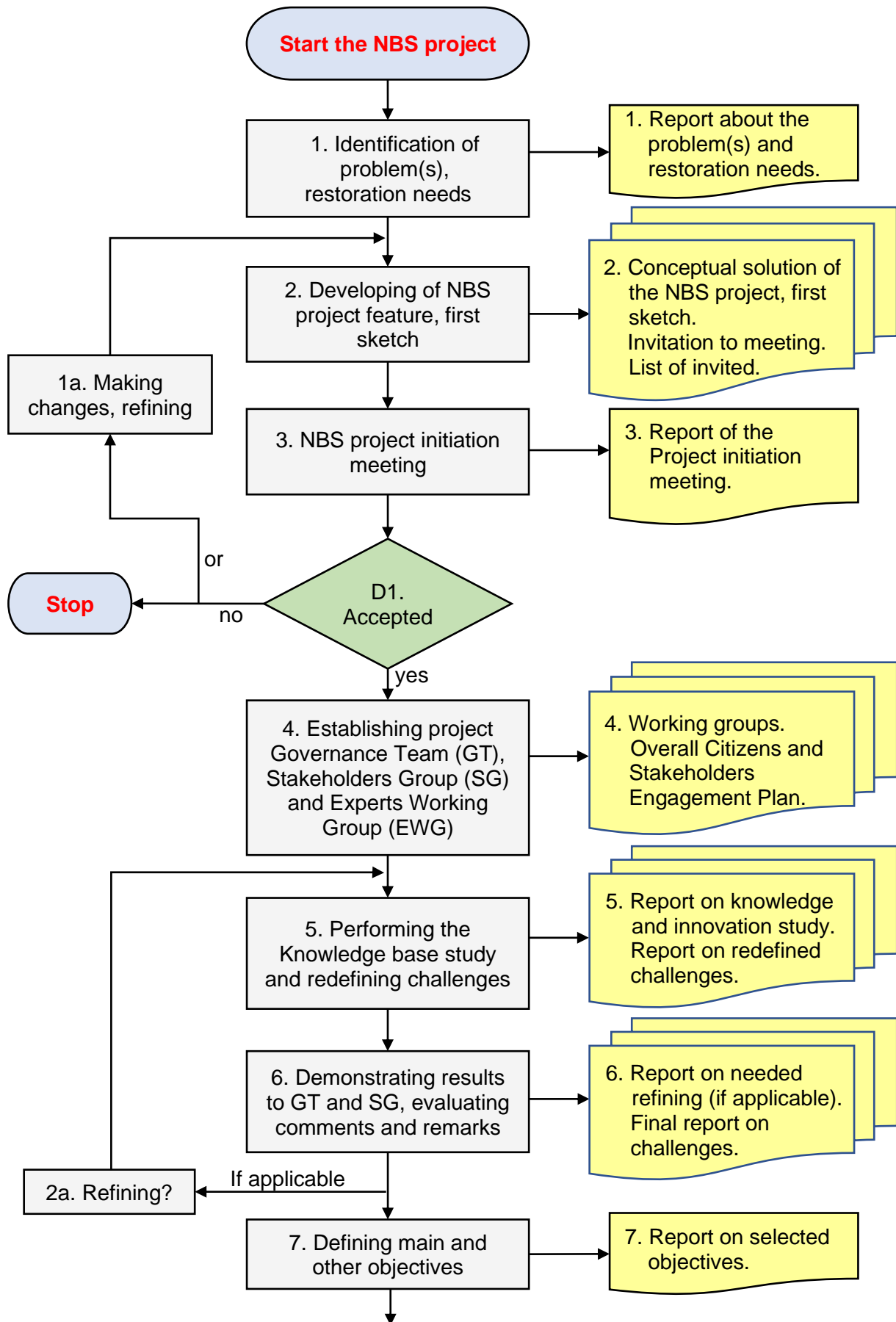
A printed document(s) or report(s).

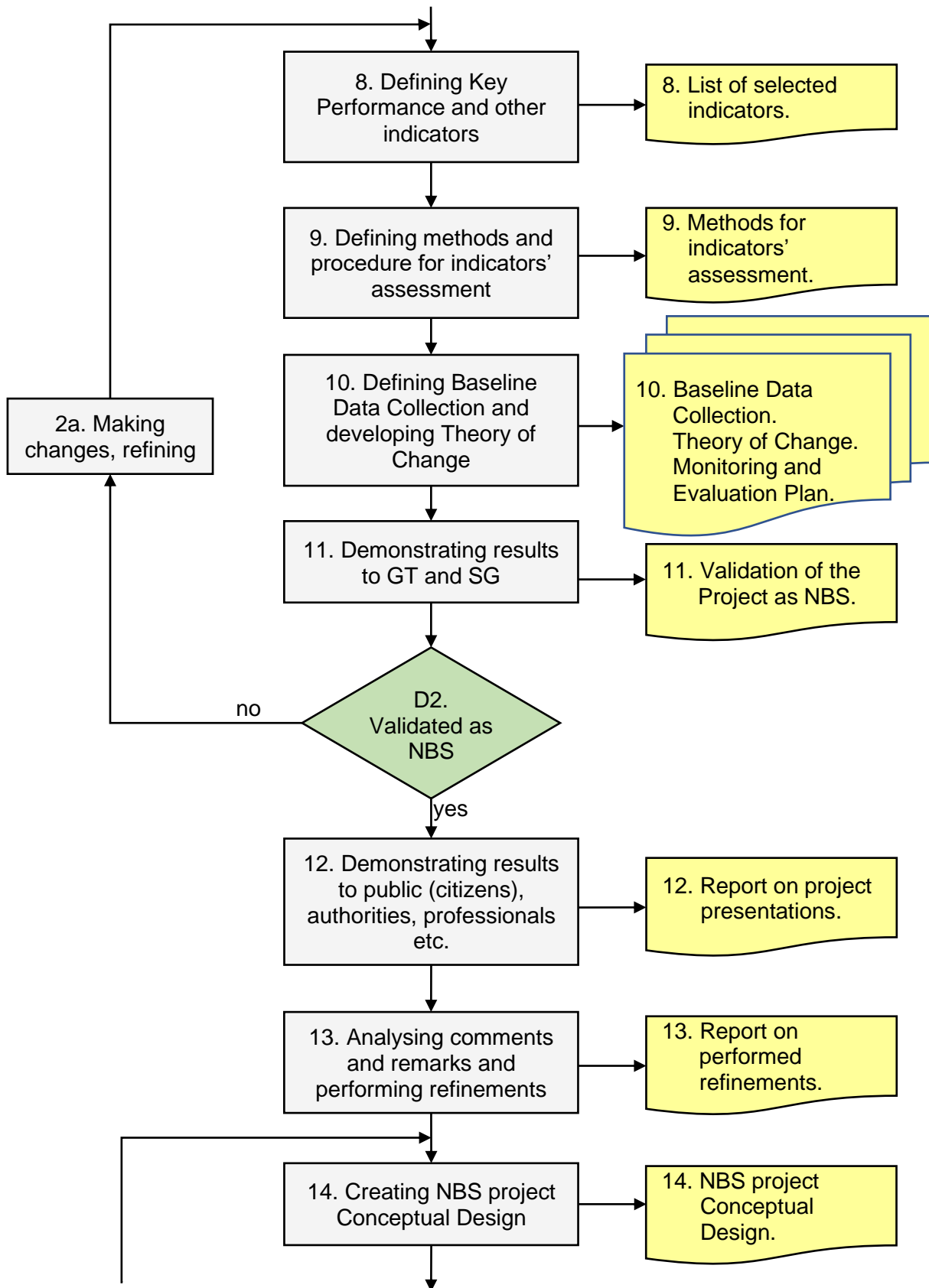
A light green diamond with a thin black border.

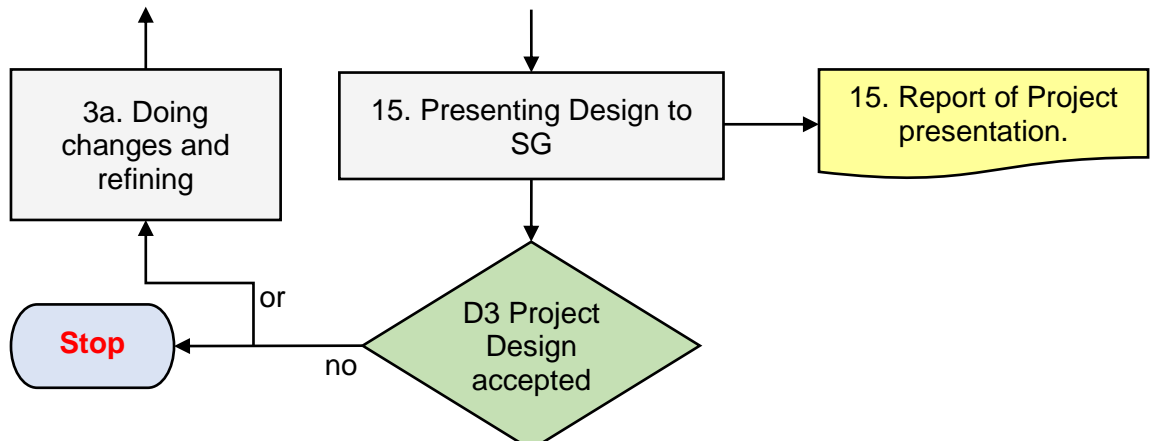
### **Decision Symbol**

A decision or branching point.

The flowchart is presented in three parts. The activities and documents are described in Tab. 6.2 and 6.3. Phase 3 is described in subchapter 6.1.2.

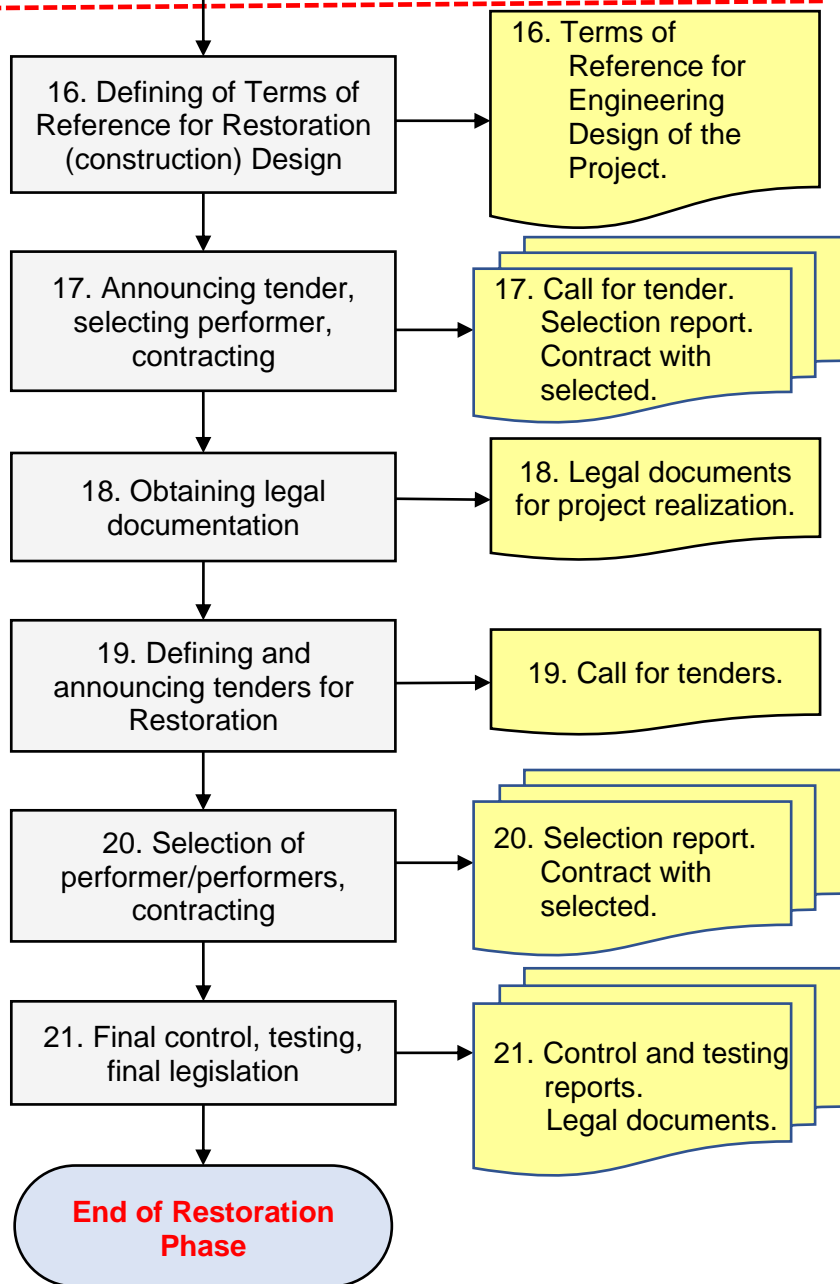






**End of NBS Assessment Phase**

**Beginning of Restoration Phase**



**Followed by Operational Phase**  
Chapter 6.1.2

Tab. 6.2 Activities

No	DESCRIPTION
1.	<p>To be performed by initiator, institution, enterprise, individuals, etc. It could be public, private, public-private, governmental institutions, scientific or technical advisors.</p> <p>Defining the location and scale.</p> <p>Defining land and water ownership and other legal issues.</p> <p>Addressing the problem(s) of river(s) or/and other water body(s) and riparian areas, biodiversity enhancement (connectivity, habitats, etc.) in line with Mission Ocean and EcoDaLLi.</p> <p>Considering needed restorations and expected effects, enhancements.</p> <p>A screening analysis is necessary to find the NBS measure best suited to the local conditions.</p> <p>Preparing a rough estimation of project realization timing, overall costs, and potential finance sources.</p> <p>Establishing the Project Core Team, (PCT). PCT (together with different stakeholders/ citizens) should provide <b>visioning</b>: by working with stakeholders, visioning would seek to transform a commonly perceived unsatisfactory situation by defining a shared vision for the future. Different time horizons can inform the exercise. Typically, decision-makers engaged in “forward planning” have concentrated on a time span of 10–20 years into the future. Choices connected to other types of interventions might involve a longer time horizon, hence being consistent with those considered in impact studies (typically half of the 21<sup>st</sup> century).</p> <p>See Chapter 3.1</p>
2.	<p>To be performed by PCT and, potentially, invited experts, outsourcing.</p> <p>Developing the first conceptual solution of the project.</p> <p>Defining societal challenges (see Chapter 4), relevant for project nomination as NBS and compatibility with Danube River Lighthouse Mission.</p> <p>Propose leading and other stakeholders. Important participation of citizens, NGOs, environmentalists, academia, public authorities...</p> <p>Proposing organization of <i>Project Initiation Meeting</i>. Propose an Organizing team.</p> <p>Preparing a List of invited participants. Date, venue, agenda.</p>
3.	<p>PTC and invited experts, citizens’ representatives, authorities, etc. present the projects and open discussion.</p> <p>Comments, changes, considering possible restructuring of the project. Considering innovations.</p> <p>See Chapter 4.3</p>
D1.	<p>The initiators and stakeholders consider comments, remarks, ideas presented and evaluate whether the Project proposal can be validated as NBS and be performed. They decide at the end of the meeting, or afterward. The result can be:</p> <ul style="list-style-type: none"> <li>➤ The Initiative accepted with no, or minor corrections.</li> <li>➤ The initiative needs refining and repetition of checking and deciding.</li> <li>➤ The Initiative not accepted.</li> </ul>
1a.	<p>Reconsidering the initiative considering comments, recommendations, and conclusions from the Project Initiation Meeting. Repetition of checking and deciding.</p>

4.	<p>Transforming PCT into the project Governance Team (GT), establishing Stakeholders Group (SG) and Experts Working Group (EWG). (EWG+ means temporary engagement of additional experts.)</p> <p>Developing of Overall Citizen and Stakeholder Engagement in Participatory Planning and Governance strategy.</p> <p>See Chapter 4.3.</p>
5.	<p>Analyzing exemplified existing projects and NBS solutions for similar problems, literature review, study of scientific databases. Insisting on innovative, scientifically grounded, solutions.</p> <p>Developing prospective long-term impact through monitoring and evaluation.</p> <p>Developing a list of criteria for assessing the performance of NBS in dealing with specific challenges. Assessing NBS' effectiveness prepared by EWG+.</p>
6.	<p>Demonstrating results to GT and SG. According to the Overall Citizen and Stakeholder Engagement strategy, organizing cross-sectoral dialogues amongst different stakeholders for fostering adaptive co-management and knowledge sharing.</p>
2a.	<p>Factoring in comments, recommendations and conclusions of the cross-sectoral dialogue, refining analysis of existing projects and NBS solutions for similar or additional problems recognized during the cross-sectoral dialogue. Analyzing trade-offs.</p> <p>Activity should be performed by GT, EWG and SG.</p>
7.	<p>Defining appropriate challenges and defining objectives (to be done by EWG)</p> <p>Proposing how to resolve legal issues in general, to be done by GT.</p> <p>Exploring funding schemes (different funding sources at different geographical scales). To be done by GT.</p> <p>Proposing possible Nature-based Solutions, to be done by GT and EWG.</p>
8.	<p>Identifying indicators: policy (general, being in line with Mission Ocean and Waters), KPI (Key Performance Indicators), and others specific for the project objectives. The selection of indicators should be performed according to RACER, SMART criteria. The number of indicators should be reduced to the lowest possible but functional level.</p> <p>Based on <b>Dumitru and Wendling</b>, 2021a and 2021b and/or other publications of EU projects. Details in Chapter 5.</p> <p>Consult SG and finalize.</p>
9.	<p>Defining metrics of the indicators, and a framework for assessing a complete set of indicators. Identifying data gathering methods for indicators, preparing a manual for measuring identified indicators. Based on <b>Dumitru and Wendling</b>, 2021a and/or other publications of EU projects.</p> <p>Consult SG and finalize.</p>
10.	<p>Determining <b>Baseline Data Collection</b>, existing values of indicators, before performing NBS project.</p> <p>The impact assessment will determine how the conditions (baseline values) will change during and after the implementation of the project. This is the base for developing a <b>Theory of Change</b>. This important document describes temporary and overall improvement of characteristics during project implementation.</p> <p>Developing the <b>Monitoring and Evaluation Plan</b>.</p> <p>See Chapter 3. Based on <b>Dumitru and Wendling</b>, 2021b, chapter DATA REQUIREMENTS, or procedures from diverse EU projects.</p> <p>To be done by EWG+.</p>

11.	EWG presenting and demonstrating to GT and SG the developed document Baseline, Theory of Change and Monitoring and Evaluation Plan. Validation of the planned project as NBS.
D2.	The result can be: <ul style="list-style-type: none"> <li>➤ The project validated as NBS with no, or minor corrections.</li> <li>➤ The project proposal needs refining and repetition of checking and deciding.</li> </ul>
2a.	Elaborating, based on remarks, and performing needed refining.
12.	According to the Overall Citizen and Stakeholder Engagement Strategy, organizing presentations (publicly announced) of the project concept to citizens, public authorities, and different professionals. Presentations should be organized by GT and EWG. See Chapter 4.3
13.	GT, EWG and SG analyzing comments and remarks and performing necessary refinements of the project concept.
14.	Creating NBS project conceptual design by GT and EWG. Conceptual design: overarching design of the NBS. Preparing economic appraisal. This moves the NBS from what is viable to a specific solution (conceptual). Developing risk assessment for the Project as part of the conceptual design. See Chapter 3.2.2
15.	GT and EWG presenting NBS project Conceptual Design to SG. Evaluating all aspects of Conceptual Design. Assessment of feasibility and appraisal of the project viability.
D3.	The result can be: <ul style="list-style-type: none"> <li>➤ The project design is accepted with no, or minor corrections.</li> <li>➤ The project design proposal needs refining and repetition of checking and deciding.</li> <li>➤ The project design is fully rejected. Project stopped.</li> </ul>
3a.	Factoring in comments, recommendations and conclusions of the GT, EWG and SG given during the presentation meeting, making additional changes and refinement. If the project design is not accepted without recommendations for possible changes and refinement, the project activities should stop.
16.	GT, EWG and SG defining Terms of Reference for Engineering (construction) Design.
17.	GT announcing tender/public procurement, selecting performer, and contracting for the engineering design. SG involved.
18.	GT obtaining common legal documentation.
19.	GT defining and announcing tender/public procurement for construction.
20.	GT Selecting performer and contracting for the construction. SG involved.
21.	GT, EWG and SG performing final control, testing, and finalizing legislation process.

Tab. 6.3 Documents

No	DESCRIPTION
1.	Report about problems, expectations/vision and proposed NBS project/intervention. The document explains identified problems or opportunities. Tries to identify root causes of the identified problems. Defines general-overall objectives. Vision. It should also contain a proposal of several possible NBS and alternative grey/hybrid solutions based on local characteristics. Defines the provisional title of the project.

2.	Conceptual solution of the Project (the first sketch). Invitation to Project Initiation Meeting, Agenda. List of invited.
3.	Report of the Project initiation meeting and decision on how to continue: start the Project, perform the suggested changes and reconsider the decision (short additional meeting), cessation of the activity. Includes induction application of innovative solutions and/or development of new ones.
4.	The decision about the structure and the roles of GT, SG and EWG. Overall Citizen and Stakeholder Engagement strategy.
5.	Report on knowledge and innovation study. List of criteria for assessing the performance of NBS in dealing with specific challenges. Document assessing NBS' effectiveness prepared by EWG. Report on redefined challenges.
6.	Minutes of different meetings with the stakeholders with detailed explanations of comments, suggestions, and recommendations. Report on refinements needed. Final report with redefined challenges.
2a.	List of possible trade-offs. Recommendation how to avoid or minimize trade-offs.
7.	A list of general (main) and specific objectives.
8.	A list of the selected indicators.
9.	A manual for determination of indicators.
10.	Document on established <b>Baseline Data Collection.</b> <b>Theory of Change.</b> <b>Monitoring and Evaluation Plan.</b> Comment: During first two phases participatory approach is integrated. The Governance Plan for Operational Phase can be drafted as a part of Monitoring and Evaluation Plan or developed after finishing restoration. This plan includes also timing for obtaining planned results.
11.	Minutes of the meeting. Document on validation of the Project as NBS.
12.	Minutes of different meetings with the stakeholders with detailed explanation of comments, suggestions, and recommendations. Report of project presentations and refinements needed.
13.	Report on performed refinements.
14.	NBS project conceptual design.
15.	Report on project presentation. The decision to accept the conceptual design, to carry out some changes and refinement if needed or to stop the project.
3a.	List of suggestions and recommendations for improvement and changes to the project design.
16.	Terms of Reference for Engineering Design of the Project with a rough estimate of costs.
17.	Call for tender/public procurement.
18.	Juristic documents for project realization.
19.	Call for tenders/public procurements.
20.	Contracts with selected performers.

21.	Control and testing reports. Legalization documents.
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### 6.1.2 Operational Phase

This phase is seldom considered and discussed in reviewed projects and publications. After completion of the projects restoration phase, follow-up investigations have to be performed. This is defined by the Monitoring and Evaluation Plan, defined in Activity 10, Tab. 6.2. This activity is of crucial importance for the project, but it is also needed to maintain the restored structure and make some improvements, if necessary. The expected outputs are defined in the Theory of Change, as well as the collection and procession of data and outcomes. If necessary, procedures for monitoring and evaluation could be modified.

Governance of restored area can be defined in the Preparatory phase, or at the beginning of the Operational Phase. Firstly, the structure of it should be defined. Who is responsible? Participation of different stakeholders, especially citizens, is obligatory. Involving trained volunteers, especially for most frequent and simpler monitoring, is preferable. Governing institutions should develop and present reports, at least once per year. This should include result and report about finances.

An especially important problem is financing of the NBS operational costs. According to Fig. 4.9 the operational costs are higher than those for planning. The maintenance should probably be performed by institutions in charge of water bodies management. Costs for monitoring and evaluation can be covered by the same institutions, funds, or other sources.

The timeline for monitoring and evaluation is defined by the Plan. The performance of these activities should involve diverse stakeholders (citizens, NGOs, national and international organizations, policymakers...) as closely as possible. Some changes to the Plan can be expected, but an annual report should be provided by the responsible body (defined within the Plan). The obtained results will be demonstrated and presented in various ways, like presentations, demonstrations, open days, discussions, etc.

During this phase diverse activities aimed at refinement of the restored area, like forestation, enriching of species, flora and fauna, creation of recreation facilities, education, etc. can be performed. It might be considered to convert the restored area, completely or partly, into a protected area. New environmentally friendly commercial ideas are welcome. An example could be freshwater fisheries. The introduction of aquaponics is one possibility.

## COMMENTS

This section outlines the **particularities, novelties, and specifications** of the methodology

The initiation of a new NBS restoration project can stem from individuals, groups of professionals, citizens, institutions, and more. Many relevant publications emphasize that project development begins with **comprehensive desk analyses** to determine if the proposed restoration can be realized as an NBS. This process can be extensive. However, Chapters 2 to 5 provide pertinent information that can significantly reduce the time and costs associated with activities leading up to decision point D.1. In many cases, especially for smaller projects, this can often be accomplished using only this deliverable or with minimal expert engagement (outsourcing). This approach clearly results in **reduced costs and working time**, representing a notable innovation of the developed methodology.

The flowchart is designed for **easy modification**, allowing for straightforward upgrades. Additionally, for more complex projects, branching can be utilized (using the same symbol as for decisions). As previously mentioned, NBS is an evolving field, and this deliverable can be easily modified as necessary.

An example of current initiatives to **engage citizens** is the recently developed publication within the Prep4Blue project (Bjørkan et al., 2023), which introduces terms such as Deliberative Democracy, Citizens Sciences Initiative, and Post-Normal Science. While aspects of citizen engagement are incorporated into the methodology, they are not treated as a separate category.

. For most planned activities, Table 6.3 indicates where relevant descriptions can be found in the preceding chapters. Stakeholders (SG) are actively involved in all relevant activities and decision-making processes.

Mission Ocean and Waters, like other similar European initiatives, strongly supports the development and implementation of innovative solutions. Chapter 3.1 highlights that many publications overlook this aspect, which is clearly addressed in the developed methodology. For specific examples, see activities 3 and 5 in Table 6.2.

The methodology has been presented to the projects like DALIA, Restore4Life, and Life Restore, and the feedback has been positive, with plans for mutual cooperation. Practitioners have raised concerns about legal issues and land and water body ownership, which could pose obstacles to the realization of NBS restoration projects. This issue has been integrated into the methodology activities.

Additionally, there are plans to create a **digest version** of the methodology, translated into the national languages relevant to the Danube River Basin, and to publish it on the EcoDaLLi Portal. This will allow stakeholders to access the information without needing to read the entire document. The digest will focus on an easy-to-use practical breakdown of the methodology framework presented in this chapter. Experts involved in the preparation of the document will provide a contact form on the EcoDaLLi Portal, offering direct support to stakeholders whenever needed.

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## 7. CONCLUSIONS

This Project deliverable and proposed methodology are based on comprehensive desk analyses of EU- funded initiatives and some other projects, which are in the line of EcoDaLLi.

The deliverable serves as a critical overview of various approaches, including comments and insights specific to the application of NBS within the Danube River Basin and aligned with Mission goals. It offers a selection of processes and methodologies tailored to the specific needs of NBS developers involved in Mission Ocean and Waters, particularly within the Danube River Basin.

The deliverable aims to be informative, accessible, and easy to understand for a diverse audience, including the general public, partners involved in the EcoDaLLi project, initiators and developers of NBS projects, practitioners, decision-makers, and students interested in nature restoration. Practically speaking, readers – such as NBS practitioners and decision-makers – are encouraged to start with Chapter 6 and refer back to appropriate sections or references as needed, as indicated in Table 6.2.

Additionally, there are plans to create a digest version of this deliverable, which will be translated into multiple languages pertinent to the Danube River Basin and uploaded to the EcoDaLLi Portal. This will allow stakeholders to access the information without needing to read the entire document. The focus of the digest will be on presenting the methodology framework to stakeholders interested in developing NBS projects in a practical and easy-to-apply way. Experts involved in the preparation of the deliverable will provide a contact form on the EcoDaLLi Portal, offering direct support to stakeholders whenever required.

For the citation of the reviewed publications, the following principles are used:

- for the scientific publication original citations are used,
- for the publication with given proposal for citation (or few of them), it was accepted; only the year of publishing is moved to the position after list of authors, if this is not a case in proposal (comment: commonly, newest publications have higher relevance),
- for confused citation relevant data, comprehensible form was created. Whenever it is possible, a website address or doi number is added.

The goals of the EcoDaLLi project are paved based on objectives of the EU *Mission 'Restore our ocean and waters by 2030': Atlantic, Arctic, Danube and Mediterranean lighthouses*. As is noted in the Introduction, **Chapter 1** WP2 is in line with these objectives as well. It has been decided to apply an up-to-date approach to Nature-based Solutions (NBS), to the highest possible extent. This relatively new term, and approach, introduced (more or less) over the last two decades, is comprehensive. It includes the previously used, eco approach, green approach, *Sustainable Development Goals* (SDGs) of the United Nations Organization, and the *European Green Deal*. In conclusion, the NBS approach represent a new step for our civilization towards performing nature restoration.

A description of NBS is performed in **Chapter 2**, starting with its history. The World Bank was one of the first, or maybe the first institution which presented the new term and approach of NBS to the wide public. The following definition can be found on the website:

*“Nature-based solutions are actions to protect, sustainably manage, or restore natural ecosystems, that address societal challenges such as climate change,*

*human health, food and water security, and disaster risk reduction effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”*

In the course of time, different definitions of NBS were developed, and some here presented. At the moment, for this project, the most suitable is the following:

Nature-based Solutions provide integrated, multifunctional solutions to critical societal challenges. They are “*solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and interventions. **Nature-based Solutions must therefore benefit biodiversity** and support the delivery of a range of ecosystem services” (European Commission).*

Considering the specific objectives of EcoDaLLi, and, especially WP2, it seems that the most suitable (covers all stated goals) is a schematic presentation of NBS in Fig. 2.2.

NBS is an emerging approach, that is very interesting for society and the future of humans and the planet. In support of this claim the reputable publisher, Elsevier, started a few years ago, with a new journal, Natural Based Solutions.

The concept of NBS is constantly developing and far from finished. That is why recent publications should be prioritized by constantly reviewing the current literature. Of course, some previous publications could be a useful and good basis for solid information, not least the ones mentioned in this deliverable.

Most of the previous EU projects, which include a NBS approach, are related to urban restoration. Some of them tackled water management, in urban and suburban areas, and biodiversity enhancement. Projects related to surface water bodies, especially those for the Danube River Basin, and those which included problems of connectivity and biodiversity were reviewed too. Unfortunately, there are only few such restoration projects which applied the NBS approach.

In **Chapter 3** terms related to the methodology: method, framework, and approach, are defined, and explained. This was continued with some general comments and remarks related to confusion, unclarities, vagueness, doubts and, in some cases, the academic bias to exaggerate.

NBS projects/interventions, are not typical, or conventional. The most significant difference is that assumed improvements should be visible/proven, after defined or not defined time periods. The first phase of planning and the second of restoration (“construction”), are followed not only by maintenance but continuous monitoring and evaluation of data, controlling the obtained results. (This third phase could be combined with diverse other activities such as reconstructions, upgrading etc.)

In the reviewed publications, a comprehensive but simultaneously simple and easily understandable example of methodology has not been found. However, useful information and solutions for the development of our own proposal were collected. The most useful information came from some publications based on EU-financed projects, like **Dumitru and Wendling (eds.)** (2021a, 2021b) and **Cardinali et al.** (2021).

If a specific planned project is in line with the definition of NBS it can be defined as a NBS. This is a crucial point in the methodology. And further elaborated in **Chapter 4.1** (p. 51).

An approach defined in the publication **Dumitru and Wendling** (2021b), defining Societal Challenges and Benefits is used. The following challenge areas are proposed as significant for the EcoDaLLi project:

2. Water Management.
5. Biodiversity Enhancement.
9. Participatory Planning and Governance.
11. Health and Wellbeing.
12. New Economic Opportunities and Green Jobs.

Depending on the concrete case other challenge areas could be selected, but challenge areas 9, 11 and 12 should be treated as indispensable.

The issue of infrastructure type is very important, but not unambiguously included in NBS definition. Absolute priority is for GREEN, BLUE, or GREEN-BLUE infrastructures. Traditional, GREY infrastructure (concrete, steel, etc.), are not in the line of NBS. An acceptable solution is HYBRID infrastructure, e.g., combined GREEN and GREY. However, it is not clearly defined to what extent the share of grey is acceptable.

**Biodiversity Enhancement** issue is dominantly related to endangered (threatened), medium and long-distance migratory, fish species. A typical medium migratory species is the Danube salmon. An example for a long distance species is the sturgeon (*Acipenser gueldenstaedtii*), which is on the brink of extinction. Another example: Danube Delta is the last refuge in continental Europe for the white-tailed eagle and white pelicans (**Anonymous, 2014**).

Biodiversity is closely related to the connectivity of surface water bodies. In some cases, it is almost impossible to realize fish passes as NBS. Typical examples are two barriers in Iron Gates. It is slightly possible to find innovative and NBS-acceptable hybrid solutions.

Flood plains and wetlands are important for biodiversity. In the past, the intention was to convert wetlands and some other surface water bodies into agricultural land. These and similar bodies are now identified as important habitats for fauna and flora, contributing to biodiversity. One of the problems is the impoundment of these, especially during lower water levels in water streams. Preventing this could be the objective of connecting and biodiversity enhancement.

Applying the challenge area **Participatory Planning and Governance** is obligatory for any NBS. Including wider stakeholders, governmental organizations, R&D and innovation entities, industry and business grouping and networks, NGOs and civil society organizations, philanthropic organizations, financing institutions etc., from the planning to the monitoring is important. They should be included in all steps, as demonstrated in Fig. 4.5 and 4.6. This was included in the developed methodology.

**Health and Wellbeing**, an issue related to social benefits, is also an important challenge area. It has taken on an even higher status after the pandemic period. In the case of EcoDaLLi, it can be relevant for the establishment of new protected areas for recreation, and sports facilities.

The issue of economic benefits, here defined as the challenge area **New Economic Opportunities and Green Jobs**, is rather complex and further elaboration is expected in the future. NBS projects are unambiguously not *Business as Usual* type. Most of the realized NBS projects were dominantly financed by public sources. It is not realistic to expect direct economic benefits, and those indirect are not easily determinable.

In the publications **McQuaid et al. (2021)** and **McQuaid et al. (2022)** interesting data for planning and realization of NBS project are presented. They coin the new terms Nature Positive Economy and Nature-based Enterprises. There are also problems identified, especially for public procurement, as well as future prospects and expected financial support for NBS developers.

In **Chapter 5** NBS indicators are elaborated. The most relevant publications for the elaboration of indicators are **Dumitru and Wendling (eds.) (2021a, 2021b)**, **Maes et al. (2020)**, **Connop (2020)** and **Alao Chanou et al. (2023)**.

The selection of proper indicators is decisive for the assessment and evaluation of NBS. They should be efficient and cost-effective. Two principles related to indicators selection are mentioned and proposed:

- **RACER** - Relevant, Acceptable, Credible, Easy, Robust, and
- **SMART** – Specific, Measurable, Attributable, Realistic, and Time-bound.

Different categories of indicators, qualitative and quantitative, outputs, outcoming, process, key performance indicators, etc. are also mentioned.

In **Chapter 6** additional publications relevant for EcoDaLLi are listed and commented upon. As a framework for Methodology the flowchart is used, whereby the activities and documents are explained in tables.

Relevant for EcoDaLLi are *Conclusions and recommendations for Lighthouse work*, presented in the chapter related to the Danube River Basin of the publication **Alao Chanou et al. (2023)**, citation:

*“Currently running and planned projects concerning river restoration in the Danube River Basin vary strongly in their temporal and spatial scope. In general, there are over-proportionally more activities and projects with regard to river restoration and river connectivity in the upper part of the DRB (e.g. Germany. Austria). This can be explained on the one hand by the distribution of alterations in the Danube and on the other hand by lack of budgets in many downstream countries.*

*Therefore, it is recommended that the focus of the mission should be on the lower Danube with regard to financial support and project replications. It is also recommended that upstream learnings are transferred to future downstream projects under the mission.*

*Assuming that the proposed nature restoration regulation will come into force and MS are required to prepare national restorations plans, the ICPDR should take an active role in coordinating these plans as regards to water issues. Such a coordination is strongly needed in order to ensure that fragmentation of ecosystem is reduced and connectivity across Danube countries is increased. Also, when developing the restoration plan, there is a need to strengthen the indicators, to be able to compare the status across different river sections and hold countries accountable to make the assessments, and potentially changes.*

*River restoration projects often face difficulties with funding, especially when it comes to securing funds for possible project-extensions or unexpected additional measures identified during the implementation phase.*



*Therefore, financing river restoration projects should be done with a mix of financial contributions, and should also have mechanisms in place to cover unexpected, additional costs which may arise to ensure that the projects can be run well. It is important to note that access to EU or international funds is an important enabling factor for larger projects.*

*The broad range of funding possibilities for river restoration projects involving also different donors requires project developers to have a good overview of these possibilities. To achieve that, often time-consuming investigations are needed in*

*order to match the project idea with the right funding scheme. This requires often discussions with a broad range of institutions. In order to ease that process, the principle of a one stop shop could at MS level be envisaged. The Points of Single Contact are e-government portals that allow project developers to get the information they need and complete administrative procedures online. However such a structure would require the development of new government structures in many MS.”*

Here we added an important goal, and task: **Wherever it is possible, Nature-based Solution should be applied.**



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