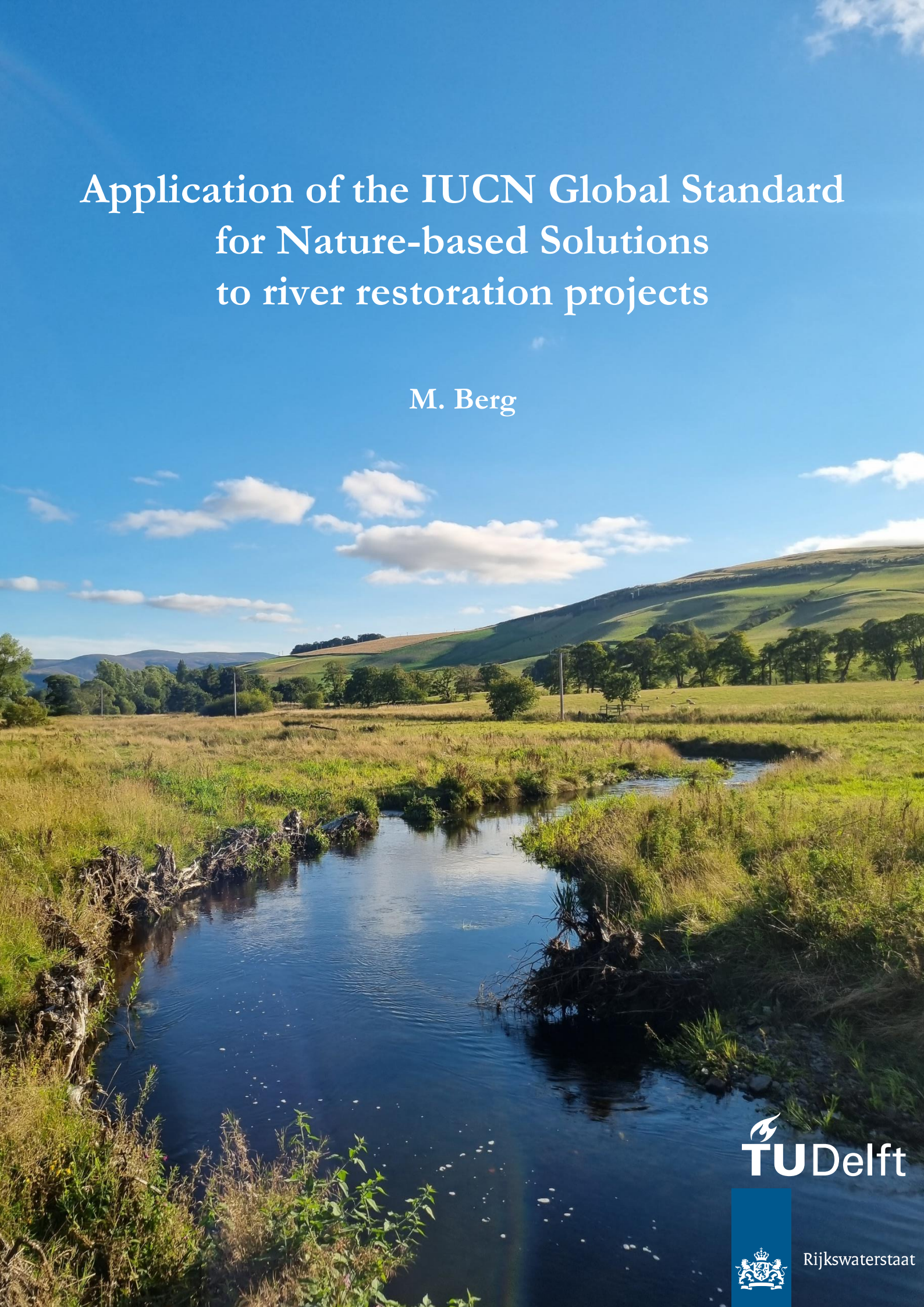
# Application of the IUCN Global Standard for Nature-based Solutions to river restoration projects

M. Berg



TU Delft

Rijkswaterstaat

# Application of the IUCN Global Standard for Nature-based Solutions to river restoration projects

by

Maikel Berg

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Cover Image: re-meandering at the Eddleston Water Project, Scotland (own photo).

TU Delft

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*Ministry of Infrastructure and Water Management*

# Abstract

Nature-based Solutions (NbS) is an increasingly popular concept referring to actions that harness nature to address major societal challenges. Implemented in river landscapes, NbS have the potential to reduce flood risk, while playing an important role in restoring many of the ecosystem services that are lost as result of human interventions and global warming. Riverine NbS include a wide variety of measures, such as re-meandering, tree planting and levee setbacks. Despite an exponential growth of the concept in scientific research, there are still many barriers to successful implementation of NbS, including the lack of a global and common framework with guidelines for its implementation and evaluation. In an attempt to develop such a framework, the International Union for Conservation of Nature (IUCN) published the IUCN Global Standard for NbS. Even though the IUCN Standard has been designed to be applicable to NbS in all sectors and over the entire globe, knowledge on its applicability and usefulness for specific sectors remains limited at present. Therefore, this study aims to analyse:

- the **applicability of the IUCN Standard** by identifying the challenges that occur in ex-post application of the standard to river restoration projects with a focus on flood risk mitigation.
- the **usefulness of the IUCN Standard** by identifying the added value that this application provides to stakeholders that are involved in the project or working on NbS through different ways.

The research approach is divided into three parts: literature study, case study applications, and discussion and conclusions. A schematic overview of the approach is provided in Figure 0.1.

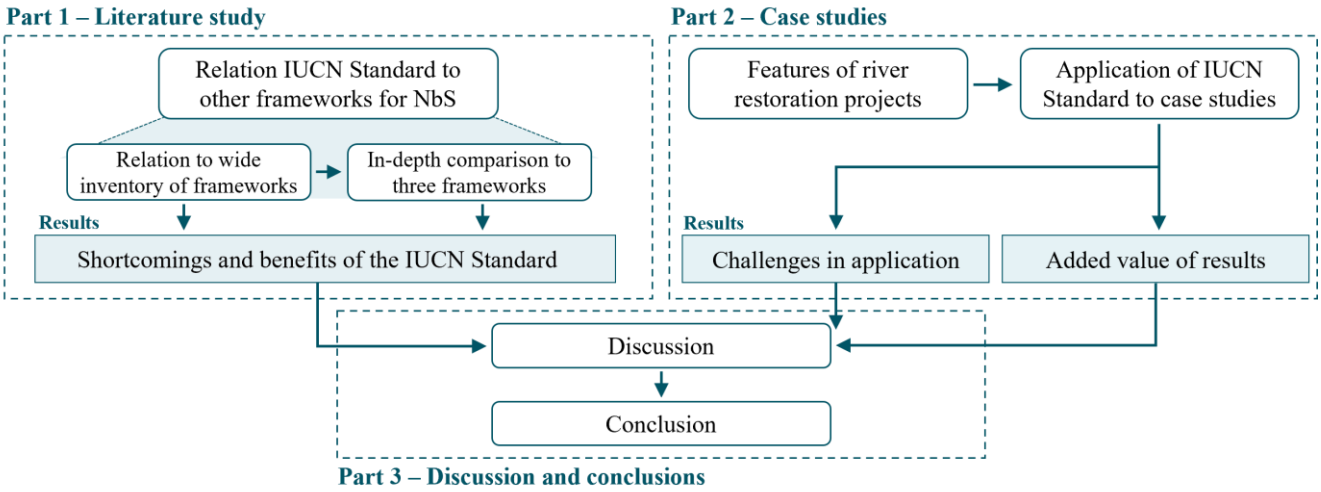


*Figure 0.1 – Research approach.*

In the literature study, the content of the IUCN Standard is related to twenty-two other assessment frameworks for NbS and compared in-depth to the frameworks by Andrikopoulou (2020), Dumitru & Wendling (2021a) and Huthoff et al. (2018). These comparisons indicate that the IUCN Standard has a broad scope of application, provides limited flexibility in assessment to its users and is descriptive, as it requires semi-quantitative input and qualitative rationale. Furthermore, the in-depth comparisons reveal that assessment frameworks can be divided into frameworks that evaluate the processes during a project, defined as *process-oriented* (e.g., IUCN Standard), or the results of a project, defined as *results-oriented* (e.g., Andrikopoulou, 2020). As a process-oriented framework, the IUCN Standard can be used as a tool to evaluate the extent to which the essential processes of a NbS, established by the IUCN, have been incorporated in a project. These essential processes include, among others, up-to-date risk management, inclusive stakeholder engagement and continuous adaptive management. The IUCN Standard can, however, not be used to evaluate project results, including biophysical and social results.

In the second part of the study, the IUCN Standard is applied ex-post to three case studies of river restoration projects with a focus on flood risk mitigation, of which at least two differ significantly in the most relevant features of river restoration projects and the types of riverine NbS measures that have

been implemented. Therefore, as a preceding step, a wide inventory of physical and non-physical features of river restoration projects is established, from which the following five features are derived as most relevant: surface area, position in the catchment, kinetic energy of the river, data accessibility and resources. In addition, riverine NbS measures are classified into the following five types: floodplain reconnection, river planform adjustments, planting or removal of vegetation, in-channel interventions and interventions in the floodplain. The selected case studies are the Eddleston Water Project, the "Room for the River" Deventer Project and the Missouri River Levee Setback Project. Despite facing a number of challenges, the IUCN Standard is succesfully applied to all case studies. A simplified overview of the assessment procedure, indicating the challenges that are faced in application of the IUCN Standard and the added value that the case study results may provide, is given in Figure 0.2.

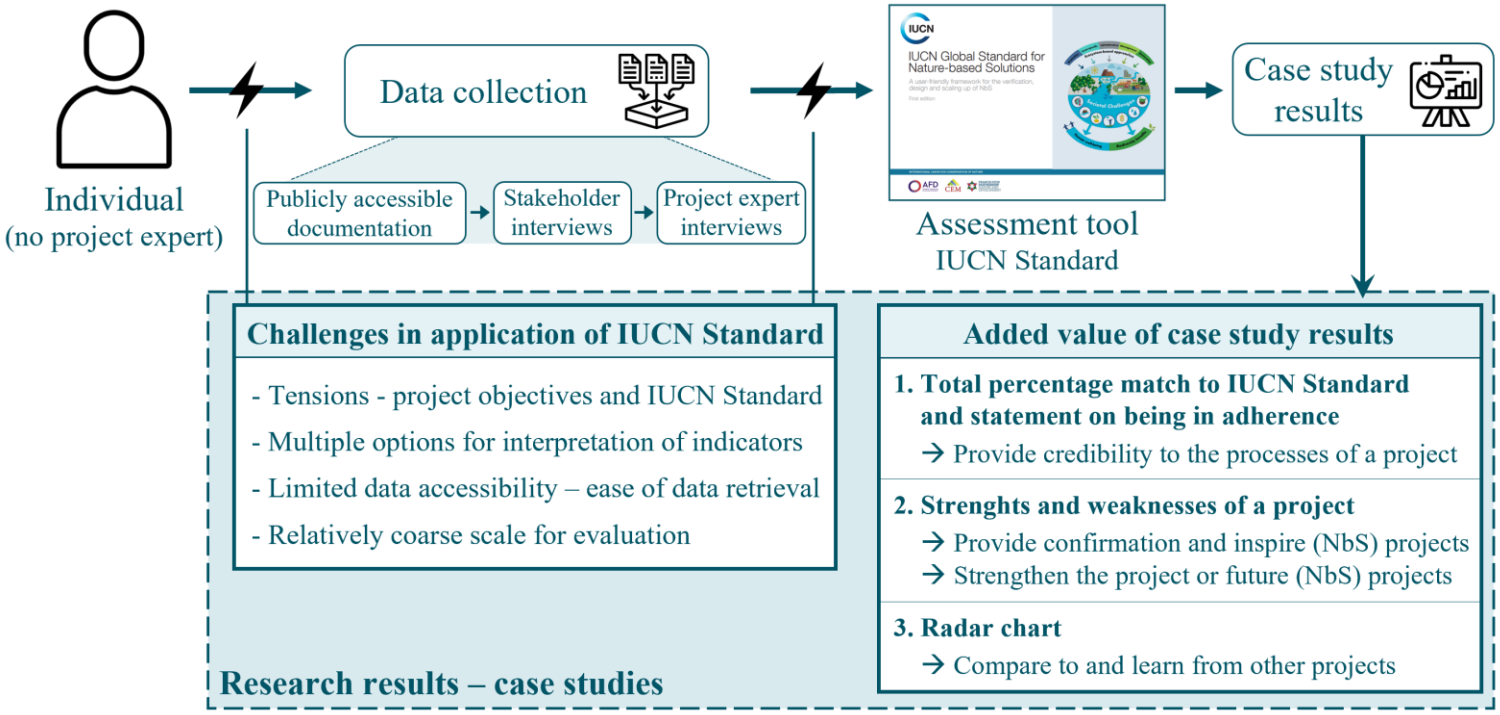


*Figure 0.2 – Methodology and results of case study assessments.*

The relation of the IUCN Standard to other frameworks and the ex-post application to three case studies allow to conclude (i) that, despite of a few challenges, the IUCN Standard is applicable to river restoration projects with a focus on flood risk mitigation and (ii) that application of the IUCN Standard may provide added value in various ways, although restricted by a limited evaluation of flood risk mitigation. These conclusions contribute to a better understanding of the applicability and usefulness of the IUCN Standard as a tool to evaluate (riverine) NbS, which was lacking in existing research.

Based on these conclusions, it is recommended to use the IUCN Standard for ex-post evaluation of a (river restoration) project for one or more of the reasons that are listed as added value in Figure 0.2. Since the IUCN Standard is a process-oriented framework and can therefore not be used for the evaluation of project results, it is suggested to use the standard in combination with a results-oriented framework. A constraint on the methodology of the literature study is that the comparison of the IUCN Standard to other frameworks is solely based on the content of the frameworks. For a complete overview of the shortcomings and benefits of the IUCN Standard, it is suggested to compare the applications of the IUCN Standard and other frameworks on case studies. Furthermore, the list of ways in which ex-post evaluation with the IUCN Standard may provide added value is based on literature review and interviews with project experts, while further validation and substantiation of these findings might need additional research. Lastly, in order to build on the evidence on the applicability and usefulness of the IUCN Standard obtained in this study, future research is recommended on its application to other sectors (e.g., urban and coastal), developing countries, well-founded NbS projects and non-NbS projects.

# Acknowledgements

This report is the final product of my master's thesis, which is the last step in the process of obtaining the master's degree in Hydraulic Engineering at the Delft University of Technology. In 2017, I graduated from secondary school and decided to start my bachelor's degree in Civil Engineering due to a combined interest in physics, geography and architecture. Now, five years later, I am putting the final touch to an amazing learning process, having obtained both my bachelor's and master's degree.

During my bachelor, I gradually acquired an interest in the field of hydraulic engineering, which increased even more once I started my master's degree in this field. As result, I followed nearly all courses of the master with great interest and enthusiasm. I became particularly fascinated by rivers and how these, sometimes enormously wide and deep, bodies of water can be extremely dynamic and provide the water and nutrients that are fundamental to most life on the planet. Additionally, I acquired an interest in measures that enable the effective and sustainable use of these natural processes, such as floodplain reconnection and mangrove rehabilitation, often embodied under the terms "Nature-based Solutions" and "Building with Nature". Together with my fascination for large-scale projects in the field of hydraulic engineering and my interest in project management, the other interests mentioned beautifully came together in the topic of my master thesis: the application of the IUCN Global Standard for Nature-based Solutions to river restoration projects.

I would like to thank my graduation committee: Ralph Schielen, Astrid Blom, Chris Spray, Yvo Snoek, Laura Stancanelli and Jill Slinger for their guidance, feedback and encouragement throughout the entire thesis. In particular, I would like to express my gratitude to Ralph for our weekly meetings and his valuable lessons in regard to the thesis, as well as for my future professional career. His enthusiasm and knowledge on the field of river engineering has inspired me a lot and I really appreciate all the time and effort he spent supporting me throughout the thesis. Furthermore, I would like to thank Astrid for her valuable suggestions that have helped me to communicate the results in a visual manner and to improve my presentation skills. My gratitude also goes to Chris, who showed me around the Eddleston Water Project and various other places during my visit to Scotland. I really appreciate that he spent an entire week with me, shared his network and welcomed me into his home.

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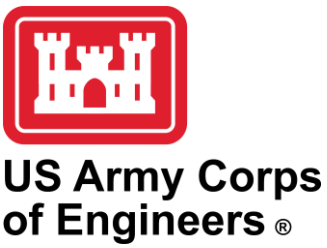
*Maikel Berg*

*Breda, December 2022*

# Acknowledgements – Companies & Organizations





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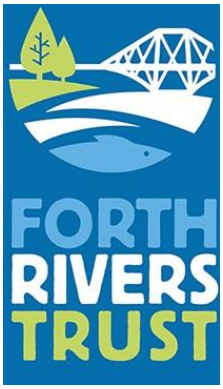



University of Dundee



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# List of Abbreviations

An overview of the significance of the abbreviations that are used throughout the report is provided in Table 0.1. The page on which each of the abbreviations is defined or first used is given as well.

*Table 0.1 – Abbreviations that are used throughout the report.*

| Abbreviation | Meaning | Page |
|---|---|---|
| BWO | **B**olwerksplas, **W**orp and **O**ssenwaard | 48 |
| BwN | **B**uilding **w**ith **N**ature | 1 |
| EKLIPSE | **E**stablishing a European **K**nowledge and **L**earning Mechanism to **I**mprove the **P**olicy-**S**cience-Society Interface on Biodiversity and **E**cosystem Services | 11 |
| ER | **E**ngineering **R**egulation | 54 |
| EU | **E**uropean **U**nion | 21 |
| EwN | **E**ngineering **w**ith **N**ature | 2 |
| H2020 | **H**orizon **2020** | 21 |
| IR | **I**nstitutional **R**eadiness | 3 |
| IUCN | **I**nternational **U**nion for **C**onservation of **N**ature | 1 |
| KSO | **K**eizers- and **S**tobbenwaarden and **O**lsterwaarden | 48 |
| MRRP | **M**issouri **R**iver **R**ehabilitation **P**rogram | 54 |
| NAIAD | **NA**ture **I**nsurance value: **A**ssessment and **D**emonstration | 11 |
| NbS | **N**ature-**b**ased **S**olution(s) | 1 |
| NFM | **N**atural **F**lood **M**anagement | 2 |
| NNBF | **N**atural and **N**ature-**b**ased **F**eatures | 2 |
| NSR | **N**orth **S**ea **R**egion | 11 |
| OPERANDUM | **OPE**n-air labo**RA**tories for **N**ature base**S** sol**U**tions to **M**anage hydro-meteo risks | 11 |
| PEARL | **P**reparing for **E**xtreme **A**nd **R**are events in coasta**L** regions | 11 |
| RECONECT | **R**egenerating **ECO**systems with **N**ature-based solutions for hydro-meteorological risk r**E**du**CT**ion | 11 |
| RfR | **R**oom **f**or the **R**iver | 38 |
| SD | **S**ustainable **D**evelopment | 19 |
| SDG(s) | **S**ustainable **D**evelopment **G**oal(s) | 1 |
| SQ | **S**ub-**q**uestion | 6 |
| UN | **U**nited **N**ations | 1 |
| UNDRIP | **U**nited **N**ations **D**eclaration on the **R**ights of **I**ndigenous **P**eoples | 17 |
| UNEA-5 | **U**nited **N**ations **E**nvironment **A**ssembly (**5**$^{th}$ version) | 1 |
| USACE | **U**nited **S**tates (U.S.) **A**rmy **C**orps of **E**ngineers | 38 |

# 1. Introduction

## 1.1 Background

Rivers can be considered as the veins and arteries of the Earth's continents, providing the water and nutrients that are fundamental to most life on the planet. As a result of human interventions, such as river straightening for navigation and the construction of embankments for flood protection, riverscapes[1] have substantially been altered over the centuries. These traditional technical solutions lead to numerous societal challenges, such as the exacerbation of floods and a decline in biodiversity (Albert et al., 2019).

Human activities are also increasingly influencing the Earth's temperature. According to the Intergovernmental Panel on Climate Change (2021), human activities are estimated to have caused 1.07 °C of global surface temperature increase above pre-industrial levels, being likely to exceed 2.0 °C during the 21st century unless deep reductions in greenhouse gas emissions occur. The changes due to global warming, such as a higher frequency and greater intensity of extreme weather events, are increasingly exacerbating major societal challenges. There is an increasing impact on nature and human well-being with biodiversity declining faster than any time in human history and ecosystems, which are the planet's life-support systems for the human species and all other forms of life, being deteriorated (IPBES, 2019; World Health Organization, 2005).

In 2015, as a universal call to action to eradicate poverty, protect the planet and reduce inequality, the United Nations (UN) established the 2030 Agenda for Sustainable Development (UN General Assembly, 2015), including 17 Sustainable Development Goals (SDGs). However, due to the past and ongoing rapid declines in biodiversity and many of nature's contributions to people, the 2030 Agenda will not be achieved based on current trajectories (IPBES, 2019).

### 1.1.1 Nature-based Solutions

Nature-based Solutions (NbS) is an increasingly popular concept with the potential to substantially contribute to the UN 2030 Agenda and to help achieve the full range of SDGs (Faivre et al., 2017). Its potential is illustrated in a study by Griscom et al. (2017), which reveals that Natural climate solutions[2] have the potential to provide 37 percent of the cost-effective climate mitigation needed by 2030 to meet the Paris Climate Agreement goal of stabilizing global warming to below 2.0 °C. In addition, recent research by Chausson et al. (2020) demonstrates that next to tackling climate change and adaptation challenges, NbS have the potential to deliver multiple environmental, economic and social benefits.

Throughout the years, numerous definitions of the NbS concept have been developed, among which definitions by the International Union for Conservation of Nature (IUCN) (Cohen-Shacham et al., 2016) and the European Commission (Maes & Jacobs, 2015). On the 2nd of March 2022, at the fifth session of the United Nations Environment Assembly (UNEA-5), a new definition for NbS has been multilaterally agreed upon. This definition is as follows:

*"Nature-based Solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits"* (United Nations, 2022, p. 2).

As the understanding of what it means to be a NbS is expected to change with human development, the definition of NbS may be quite different in the future (Slinger & Vreugdenhil, 2020). The concept of effectively using natural processes and interactions in managing ecosystems and designing infrastructure has existed for a long time under various names. Other terminologies for similar concepts include "Building with Nature" (BwN) (De Vriend & Van Koningsveld, 2012), "Engineering with Nature"

[1] Riverscapes is the dedicated term to refer to river landscapes (Collins Dictionary, n.d.).

[2] Natural climate solutions are solutions that increase carbon storage and/or avoid greenhouse gas emissions. They are encompassed by the NbS concept (Chausson et al., 2020).

(EwN) (Bridges et al., 2014), "Natural and Nature-based Features" (NNBF) (Bridges et al., 2021a), "Natural Flood Management" (NFM) (Wren et al., 2022), "ecosystem-based adaptation" (Colls et al., 2009) and "Cyclic Floodplain Rejuvenation" (Vreugdenhil et al., 2010). The research on most of these concepts has largely been site-specific and is therefore limited in its generalizability. As a relatively new term for the concept, NbS has the widest scope and can be considered as an umbrella concept that covers a whole range of ecosystem-related approaches (Cohen-Shacham et al., 2016; Kabisch et al., 2017). For this reason, Nature-based Solutions is the term adopted in the remainder of the report.

The first usage of the term Nature-based Solutions dates back to 2002 (Cohen-Shacham et al., 2016), while the first major publications focusing on NbS were published by the World Bank (2008) and IUCN (2009). After that, an almost exponential growth of NbS and related terminology is noticeable in scientific research and literature (Schielen et al., 2020). The latest key events in the development of the NbS concept have been the UNEA-5 and the 2022 UN Climate Change Conference (COP27, 2022), which both had an increased focus on NbS compared to previous editions and recognized the important role of NbS in the response to climate change and its social, economic and environmental effects (NbS Initiative, 2022; NetworkNature, 2022).

### 1.1.2 NbS in riverscapes

A particular useful setting for the implementation of NbS may be riverscapes, where they can play an important role in the emerging efforts to future-proof riverscape development for people and nature (Albert et al., 2021). Through the restoration of riverscapes, much of the biodiversity and many of the ecosystem services[3] lost as a result of human interventions and the consequences of global warming can potentially be brought back (Albert et al., 2019). Riverine NbS include a variety of measures, of which examples are provided in Figure 1.1. Reconnecting the river with its floodplains is a clear example of a NbS measure, as it addresses the societal challenge of flood risk by increasing the discharge capacity, while potentially delivering co-benefits, such as habitat (re-)creation and recreational possibilities.

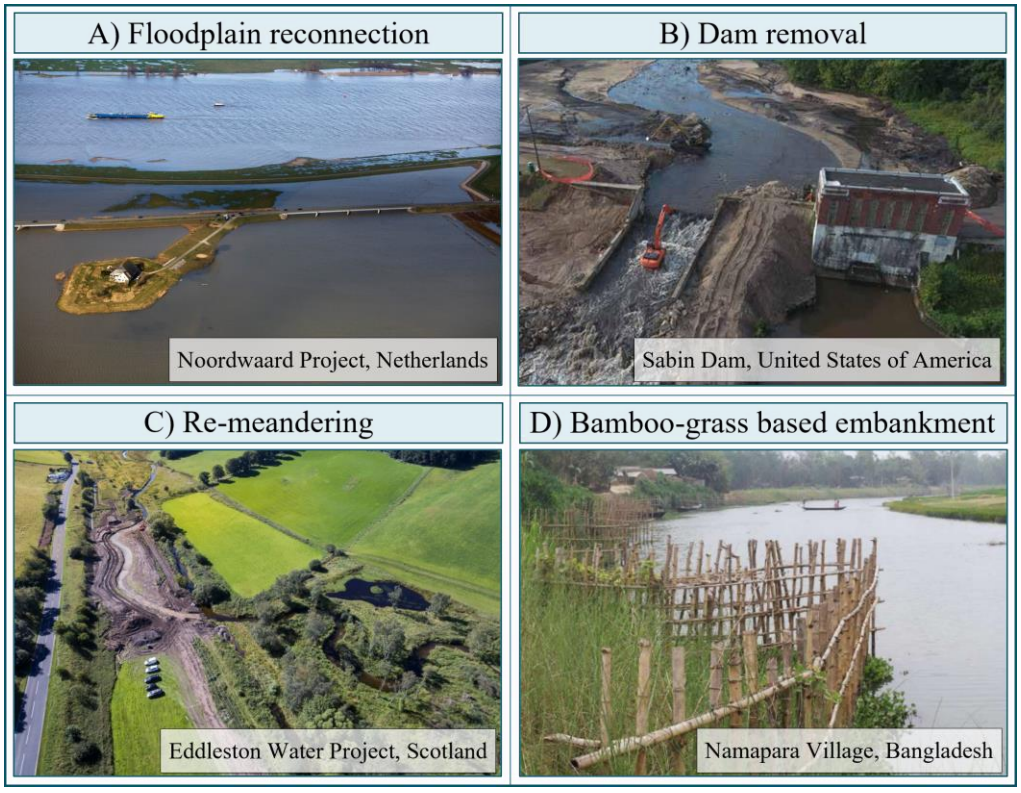


*Figure 1.1 – Examples of riverine NbS - (a) Floodplain reconnection (Rijkswaterstaat, 2020); (b) Dam removal (Bridges et al.,, 2021b); (c) Re-meandering (Spray et al., 2022a); (d) Bamboo-grass based embankment (Shina & Bimson, 2021).*

[3] Ecosystem services refer to the benefits that people obtain from ecosystems (World Resources Institute, 2003).

### 1.1.3 Barriers and enablers for NbS implementation

Despite the fact that the NbS concept is growing exponentially in popularity, there are still many barriers to the successful implementation of NbS. Thereby, these barriers also pose limitations to the next steps in the development of the NbS concept: upscaling (i.e., making the next step forward from small pilot projects to projects on a larger spatial scale) and mainstreaming (i.e., ensuring that NbS is always part of the full set of solutions for certain societal challenges). Examples of barriers in the implementation of NbS are the limited amount of quantitative scientific evidence of its benefits, the varying regulatory frameworks for its implementation, the lack of guidelines for implementation and evaluation, and the costs, effort and expertise associated with the required modelling, monitoring and adaptive management (Bridges et al, 2021a; Schielen et al., 2020). Other barriers are the silo mentality of institutions[4], the inherent uncertainty of NbS, the lack of financial resources (Sarabi et al., 2020), and the social dilemma of a multi-functional NbS being attractive to a coalition of stakeholders, while not being the most beneficial solution to individual stakeholders (Janssen et al., 2020; Vreugdenhil et al., 2022).

On the other hand, there are numerous factors, also known as enablers, that can potentially lead to successful implementation of NbS. Two examples are the scientific research on the quantification of benefits of NbS and the development of a framework with guidelines. Another important enabler for the implementation of NbS is early and proactive stakeholder engagement, as this allows for elaborate consideration of the local and system context (Slinger, 2021). Furthermore, as NbS are intrinsically dynamic, it is important to embrace its dynamics and uncertainties (Moons et al., 2021). While existing approaches to NbS adoption use the concept of Technology Readiness Levels, which assesses the maturity of the inherent technology, the actual readiness of NbS adoption depends on the broader perspective of Institutional Readiness (IR), in which is conceptualized how new technologies are in fact adopted in organizational setting. The embracement of the dynamics and uncertainties of NbS plays an important role in increasing IR for NbS adoption (Van Cauwenbergh et al., 2022; Webster & Gardner, 2019). Lastly, important enablers for successful implementation of NbS are the execution of modelling, monitoring and adaptive management. The acquisition of funding for these enabling activities at present remains wide open to research with suggestions to combine diverse funding streams (Moons et al., 2021; Bridges et al., 2021a), while Janssen et al. (2020) and Vreugdenhil et al. (2022) identified the acquisition of funding from different public funding sources to be fundamentally problematic.

### 1.1.4 Assessment frameworks for NbS

One of the enablers to successful implementation of NbS mentioned in the previous section is the development of a framework and/or standard with guidelines for the implementation and evaluation of NbS. Together with the increase of the NbS concept in scientific literature, numerous assessment frameworks have been developed with the most prominent frameworks having been published since 2016. Assessment frameworks refer to frameworks that can be used for a periodic and objective assessment of a planned, ongoing or completed NbS project used selectively to answer specific questions related to design, implementation and/or results (Veerkamp et al., 2021; Dumitru & Wendling, 2021a).

There are various ways in which an assessment framework can be an important enabler to successful implementation of NbS, of which examples are listed below.

- The guidance and/or questions related to design can help to translate a concept into targeted actions for implementation.
- Regular assessments can be used to monitor the technical and/or economic performance of implemented NbS measure(s) (Dumitru & Wendling, 2021a).
- The results of assessments can provide tangible value to a project, which can lead to a complete, inclusive and fair business case, helping to offer credibility to policy makers, funders and other stakeholders (Moons et al., 2021).

[4] The silo mentality of institutions refers to different institutions operating on the basis of distinct visions, goals, legal structures and ways of thinking (i.e., stuck in their silos) (Sarabi et al., 2020).

Assessment frameworks for NbS differ with respect to scope and intended use. Examples are frameworks that are applicable to NbS in urban (e.g., Beceiro et al., 2022), rural (e.g., Pugliese et al., 2022) or riverine (e.g., Andrikopoulou, 2020) environments and frameworks that are designed to be used prior to implementation of the project (i.e., ex-ante) (e.g., Calliari et al., 2019), during implementation (i.e., operational) and/or after implementation (i.e., ex-post) (e.g., Watkin et al., 2019). The disadvantage of the development of a variety of assessment frameworks, being applicable in different types of scenarios, is the lack of a common grouping of terms and interchangeability in language regarding the NbS concept. A global and common assessment framework, providing guidance for implementation, monitoring and evaluation of all types of NbS, may result in such a common grouping of terms and interchangeability in language. Even though barriers in the communication between people working on NbS in different sectors (e.g., urban and rural) and with different interests (e.g., project managers, policy makers and funders) will always exist, having access to a common framework and corresponding language can potentially increase the ease of communication between the people working on NbS. This may be beneficial to succesful implementation of NbS, as well as contribute to the next steps of upscaling and mainsteaming NbS.

### 1.1.5 IUCN Global Standard for NbS

In an attempt to develop a global and common assessment framework for NbS, as described in the previous section, the IUCN published the "IUCN Global Standard for Nature-based Solutions" (IUCN, 2020a). The IUCN Global Standard for NbS, which is abbreviated to IUCN Standard in the remainder of the report, is intended to be used by anyone working on the design, verification and scaling up of NbS. It consists of eight criteria (i.e., essential principles of a NbS), each with a set of indicators, adding up to twenty-eight indicators in total. The indicators represent different components of the criteria and can be used as guiding principles for design or qualitative parameters for evaluation. Each of the criteria and their mutual connection are represented by Figure 1.2a. Criterion 1 focuses on the identification of the societal challenge(s) to which the project is a response. To this matter, the IUCN recognizes seven major societal challenges that can potentially be addressed by NbS, represented in Figure 1.2b.

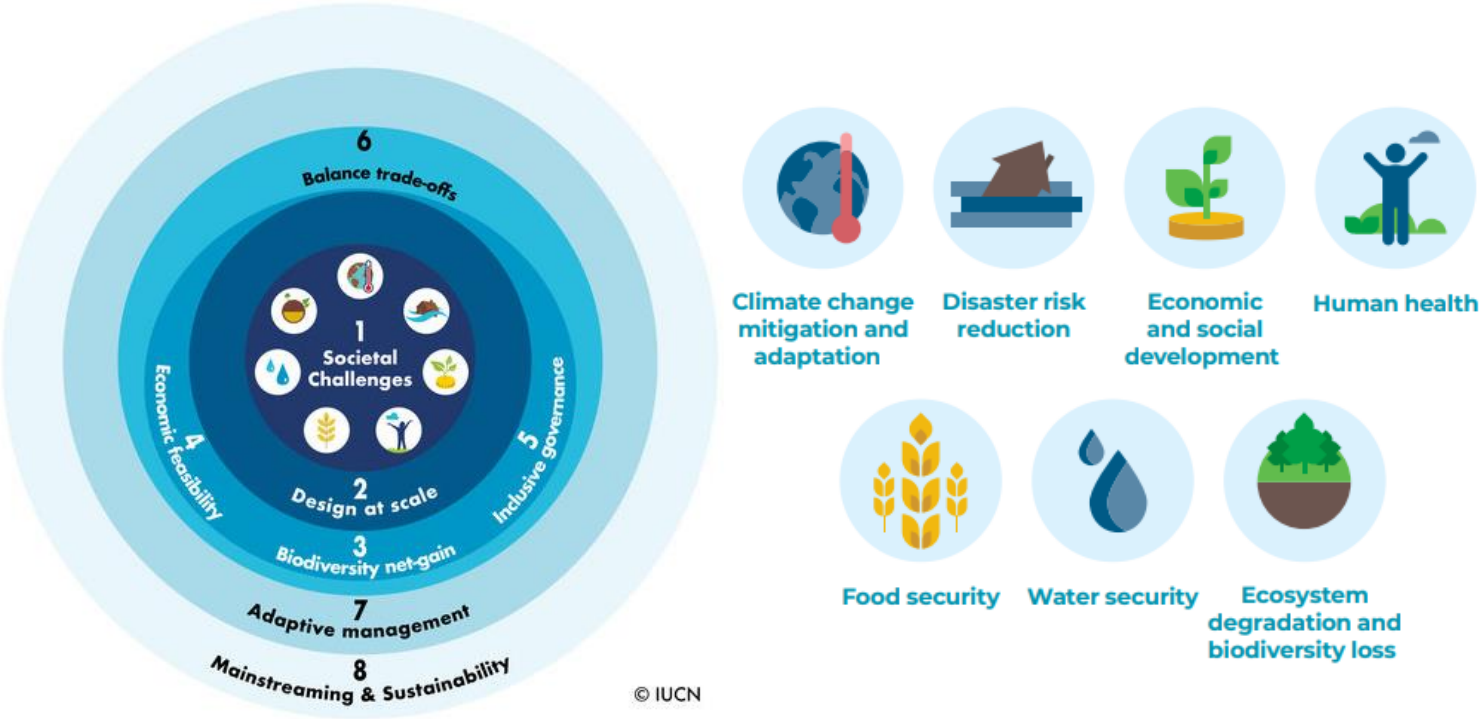


*Figure 1.2 - (a) The eight criteria of the IUCN Standard, which are all interconnected (IUCN, 2020a); (b) The major societal challenges addressed by NbS (Le Gouvello et al., 2022).*

As the IUCN Standard has only recently been published, the amount of publications on its application to projects is limited. While the IUCN Standard was still under development, a preliminary version of the criteria was used by Shina & Bimson (2021) for ex-post analysis of seven case studies in the Ganges Brahmaputra Meghna river basin to identify key points on which these can be strengthened. Furthermore, in recent desk studies by Le Gouvello et al. (2022) and Rinsa et al. (2022), the IUCN Standard has been used for preliminary ex-post assessments of the general concepts of seaweed farming in Zanzibar, Tanzania and water management in Bali Island, Indonesia, respectively. The purpose of these studies was to assess the eligibility of both concepts as NbS and identify challenges on which these can be strengthened. In addition to these applications, a study by Pakeman et al. (2021) selected the IUCN Standard as the most suitable framework for Scotland's terrestrial and aquatic systems out of a comparison to twenty-three other frameworks for NbS and recommended applications of the IUCN Standard (in Scotland) to provide a template for others to follow in embedding NbS in future thinking.

## 1.2 Problem statement

In contrast to most other assessment frameworks, the IUCN Standard has been designed to be applicable to NbS in all sectors and over the entire globe. As result, it has the potential to provide a common grouping of terms and interchangeability in language for NbS throughout different sectors, which is likely to improve the communication between people working on NbS. In addition, the IUCN Standard has the potential to be a valuable framework for design, implementation and evaluation of NbS in riverscapes, which may contribute to the emerging efforts in developing future-proof riverscapes for people and nature. However, as the IUCN Standard has only recently been published and until now there are few publications on its application to projects, the knowledge on its applicability and usefulness for specific sectors remains limited at present. The problem fundamental to this study is therefore the uncertainty of whether the IUCN Global Standard for NbS can effectively be applied as an assessment framework for NbS in riverscapes, varying in scope.

## 1.3 Research definition

### 1.3.1 Research scope

The IUCN recognizes seven major societal challenges that can potentially be addressed by NbS, given in Figure 1.2. The scope of this research is limited to the application of the IUCN Standard to river restoration projects with a focus on addressing the societal challenge of disaster risk reduction. In the context of river restoration projects, this challenge can be defined as flood risk mitigation. This does not exclude projects that, next to a focus on flood risk mitigation, also contribute to other societal challenges.

Furthermore, the IUCN Standard has been designed for ex-ante, operational and ex-post applications. In order to allow a fair comparison between applications of the IUCN Standard, the use of the standard within this research is limited to ex-post assessment of a project. Lastly, the research covers the application of the IUCN Standard by an individual that is not an expert on the project.

### 1.3.2 Research objective

The main objective of the research is to determine whether the IUCN Global Standard for NbS can effectively be applied for ex-post assessment of river restoration projects with a focus on flood risk mitigation. Within this research, a distinction is made between the applicability and the usefulness of the IUCN Standard. The applicability of the IUCN Standard is analysed by identifying and evaluating the challenges that occur in its application, while the usefulness of the IUCN Standard is analysed by identifying which stakeholders, and in what way, can potentially obtain added value from application of the standard. The considered stakeholders include people involved in the project on which the IUCN Standard is applied and people working on NbS through different ways, who may benefit from application of the standard on the project (e.g., people involved in other NbS projects).

This provides the following main research question:

**Which challenges occur in the application of the IUCN Global Standard for NbS on river restoration projects with a focus on flood risk mitigation, and what added value does this application provide to stakeholders?**

The path towards answering the main research question is divided into three sub-questions (SQ's):

**SQ1.** How does the IUCN Global Standard for NbS relate to other assessment frameworks for NbS that deal with physical interventions for riverine flood risk mitigation?

**SQ2.** What are the most relevant physical and non-physical features, based on which river restoration projects can be classified?

**SQ3.** Which challenges are identified by applying the IUCN Global Standard for NbS to case studies, and what added value does this application provide to stakeholders?

## 1.4 Research approach and structure

The report is divided into seven chapters. **Chapter 1** consists of background knowledge, the problem definition, research scope and objective, and an introduction into the research approach. In **Chapter 2**, the research approach is covered in more depth. The main body of the report consists of three parts: literature study, case study applications, and discussion and conclusions, depicted in Figure 1.3. The first sub-question is addressed by means of a literature study in **Chapter 3**, in which the IUCN Standard is related to a wide inventory of frameworks for NbS and compared in-depth to three of the most relevant frameworks with the purpose of identifying the shortcomings and benefits of the standard.

In **Chapter 4**, the second sub-question is addressed by conducting a literature research on the most relevant features, based on which river restoration projects can be classified. **Chapter 5** covers the application of the IUCN Standard to case studies, which require to differ sufficiently in the selected features. The purpose of the case study assessments is to identify the challenges faced in application of the standard and the added value that this application provides, addressing the third sub-question. In the third part of the research, **Chapter 6** discusses the results, which includes the verification of the identified shortcomings and benefits of the IUCN Standard by the results of the case study assessments. In addition, it covers the limitations and relevance of the research. Lastly, **Chapter 7** answers the research questions and provides recommendations for the use of the IUCN Standard and future research.

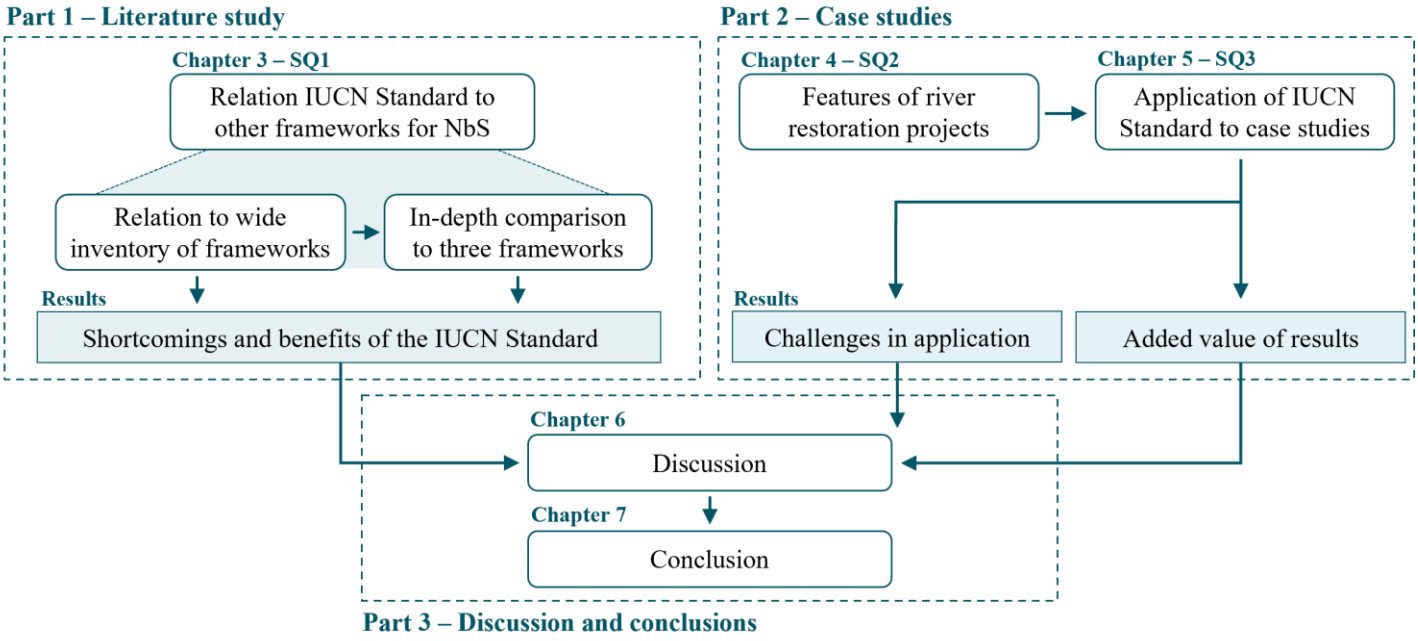


*Figure 1.3 – Research structure and approach.*

# 2. Methodology

This chapter covers the research approach towards answering each of the three sub-questions. The methodology of the literature study, in which the IUCN Standard is related to other frameworks, is given in section 2.1. Furthermore, the approaches for selecting the most relevant features of river restoration projects and conducting the case study assessments are provided in sections 2.2 and 2.3, respectively.

## 2.1 Relation IUCN Standard and other assessment frameworks

In the past decade, a large number of assessment frameworks for NbS, with differences in scope and intended use, have been developed. Analysis of the relation between the IUCN Standard and other frameworks for NbS allows to identify key elements that are missing in the IUCN Standard (i.e., shortcomings) and key elements of the IUCN Standard that users would benefit from relative to application of other frameworks (i.e., benefits). These shortcomings and benefits of the IUCN Standard in relation to other frameworks point out the strong and weak points of the standard on which additional attention should be paid during its application to case studies.

The methodology for relating the IUCN Standard to other frameworks for NbS is divided into two steps. First, the IUCN Standard is related to a wide inventory of frameworks with the purpose of positioning the standard in relation to other frameworks, providing general insights such as the relative broadness in scope of application, descriptiveness and flexibility of the standard. Next, these general insights are complemented with more specific insights related to the content of the IUCN Standard (e.g., missing topics and shortcomings in deliverables), which is achieved through a more in-depth comparison of the standard with three of the most relevant assessment frameworks. The research approach for these two steps is covered in more depth in sections 2.1.1 and 2.1.2.

### 2.1.1 Position of IUCN Standard in relation to other frameworks

A literature research is carried out to establish an inventory of relevant assessment frameworks for NbS. In order to keep the literature research manageable, solely assessment frameworks are considered that meet the following requirements:

- Consisting of explicit guidance for the assessment/evaluation of a (potential) project.
- Explicitly designed for NbS or similar concepts.
- Applicable to physical interventions for riverine flood risk mitigation.

This implies that frameworks that solely provide guidance on implementation and monitoring or that focus on urban or coastal applications, without a direct connection to rivers, are excluded. The literature research is carried out in search engines Google Scholar and ResearchGate using the search terms provided in Table 2.1. The combined search string includes one search term of the categories “Concept”, “Assessment element” and “Framework element’”, with and without addition of a search term of the categories “Scope – area” and/or “Scope – societal challenge”. Furthermore, the search is limited to articles published since 2016. The identified frameworks are complemented through application of the Snowball Method[5], in both forward and backward direction. In case the Snowball Method yields a relevant framework that was published prior to 2016, the framework is included in the inventory.

Subsequently, the identified frameworks are examined with the purpose of identifying the main differences in scope and intended use. Furthermore, potential links between the frameworks and the UN SDGs are explored, as NbS have the potential to substantially contribute to the SDGs and such a link could therefore increase the added value provided by application of a framework. Potential links with the IUCN are explored as well, as this demonstrates the awareness and use of IUCN publications in the frameworks. The next step is a comprehensive analysis of the IUCN Standard such that it can be related

[5] The Snowball Method is a method in literature review where an article is used to identify where it was cited (forward snowball) or what citations were used in the article itself (backward snowball) (Rosado, 2020).

to the inventory of frameworks with the purpose of providing general insights, such as the relative scope of application and descriptiveness of the standard.

*Table 2.1 – Search terms used for literature research on assessment frameworks for NbS.*

| Category | Search terms |
|---|---|
| Concept | "Nature-based Solutions" OR NbS OR "Building with Nature" OR BwN OR "Natural Flood Management" OR NFM |
| Assessment element | assessment OR evaluation |
| Framework element | framework OR guidelines |
| Scope – area | river OR fluvial |
| Scope – societal challenge | flood risk |
| Publication date | > 2016 |

### 2.1.2 Comparison with three of the most relevant frameworks

A selection of three of the most relevant assessment frameworks, which are extensively compared to the IUCN Standard, is made based on the following additional requirements and wishes:

**Requirements**

- Applicable for **ex-post** assessment.
- **No modelling** required for conducting the assessment.*
- Consisting of **indicators** for assessment, in the form of:
  - prescribed (fixed) list(s) of indicators, or
  - concise list(s) of examples of indicators to choose from.

**Wishes**

- Selected frameworks should **not be closely related**: selection of most recent framework.
- Guidance on usage of the indicators should be **clear and elaborate**.

* This excludes modelling that might be performed for data collection.

Next, the selected frameworks are extensively analysed and compared to the IUCN Standard to provide more specific insights on the content of the IUCN Standard. Together, the general insights resulting from positioning the IUCN Standard to a wide inventory of frameworks and the specific insights from in-depth comparisons with three of the most relevant frameworks provide a complete overview of the shortcomings and benefits of the IUCN Standard in relation to other frameworks for NbS.

## 2.2 Features of river restoration projects

The second part of the research covers the application of the IUCN Standard to case studies. In order to ensure that the case studies differ sufficiently to yield valuable results from comparison, the case studies are required to differ in the most relevant features, based on which river restoration projects can be classified. Therefore, as a preceding step to case study selection, a selection is made of the five most relevant physical and non-physical features of river restoration projects. Examples of physical and non-physical features of river restoration projects are the surface area of the project and the stakeholder involvement, respectively. The specific NbS measures that are actually implemented in a project are dependent on many of these features, as well as a decision made by individuals, and therefore take place at a higher level in the characterization of river restoration projects than the individual features. Therefore, the types of riverine NbS measures are also considered as a relevant element, based on which river restoration projects can be classified and in which the case studies require to differ. For this purpose, the types of riverine NbS measures are classified into five categories.

The methodology for selecting the most relevant features of river restoration projects and classifying the types of riverine NbS measures consists of three main steps. First, an inventory of a wide variety of

physical and non-physical features of river restoration projects is established based on a literature research in search engines Google, Google Scholar and ResearchGate. Next, a selection is made of the five features that are thought to be most significant in the classification of river restoration projects. For instance, the surface area of the project is very significant in classifying large- and small-scale projects, while a difference in river water quality is less significant in classifying different projects. The third step is the classification of the most common types of NbS measures for river restoration purposes into five categories, which is based on a literature research for other classifications of river restoration measures in search engines Google, Google Scholar and ResearchGate.

## 2.3 Application of the IUCN Standard to case studies

The IUCN Standard is applied to case studies with the purpose of identifying the potential challenges in this application and the added value that this application may provide to stakeholders, referring to people involved in the case studies, as well as people working on NbS through different ways. To begin with, three case studies are selected that meet the requirements provided in Figure 2.1, which are divided into core features in which the case studies require to be similar and features in which at least two of the case studies require to differ significantly.

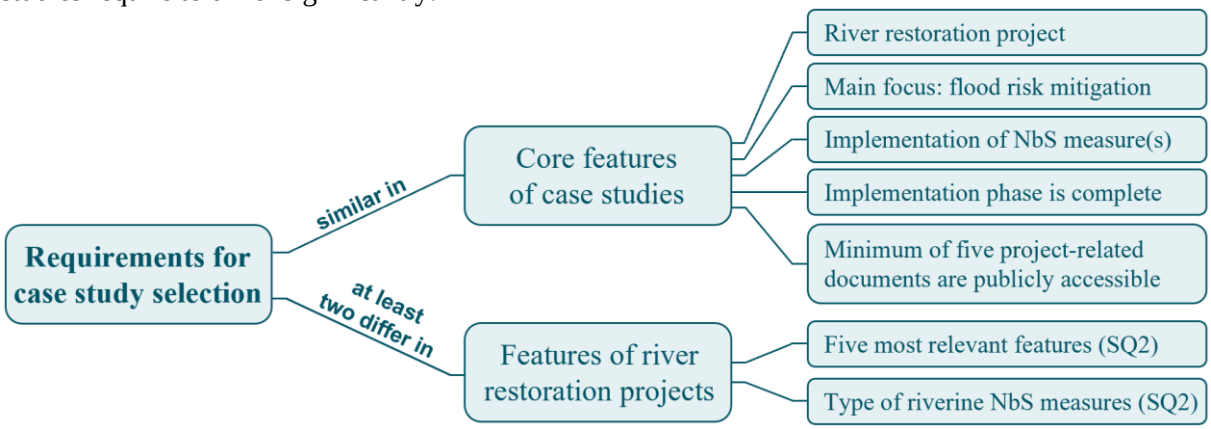


*Figure 2.1 – Requirements for case study selection, where "SQ2" implies that the features follow from sub-question 2.*

After case study selection, an inventory of the required data for completion of the case study assessments is established. The procedure for data collection consists of the following three steps:

**1 – Analysis of publicly accessible documentation**

A literature research is carried out in search engines Google, Google Scholar and ResearchGate using the name of the case study and associated terms in English and, if relevant, in Dutch as search terms. Both grey and white literature are included in the research. A selection is made of five to eight of the most significant project-related documents (e.g., scoping studies, project reports or monitoring reports) to be analysed for the collection of the required data. This analysis is performed by effectively scanning through the document to identify potentially relevant data, while making notes in a systematic manner.

**2 – Stakeholder interviews**

The next step in data collection is interviewing stakeholders that have directly been affected by the project to collect data on their experiences with the project. Examples of directly affected stakeholders are landowners with measures on their land and local citizens that experience its consequences. For the stakeholder interviews, a different methodology is used for each of the three case studies in order to research whether, and to what extent, the inability to collect data from stakeholders poses a challenge in the application of the IUCN Standard. The methodology for the three case studies is as follows:

- **Case study 1:** Six stakeholder interviews with three different stakeholder types.
- **Case study 2:** One stakeholder interview with a key stakeholder.
- **Case study 3:** No stakeholder interviews.

An information sheet with the relevant questions is established based on the required data concerning stakeholder experiences. The interviews take 10 to 30 minutes and are conducted in-person or online.

**3 – Project expert interviews**

In order to collect the required data that is not collected through analysis of the selected project-related documentation and stakeholder interviews, interviews with project experts are conducted. To qualify as a project expert, one requires to have been closely involved in the project in a planning, managing or researching role for a significant part of the project duration. Based on the missing required data, an information sheet with the relevant questions is established. Interviews with one or more project experts of ½ to 1 ½ hours are conducted in-person or online until all of the required data is collected. If relevant, someone with knowledge of the project monitoring, referred to as "monitoring expert", is contacted to retrieve specific data on monitoring that the project experts were not able to provide.

With the purpose of researching whether a field visit to the project location has an influence on the applicability of the IUCN Standard, the data collection procedure included a field visit of three days, a half day and no field visit for case studies 1, 2 and 3, respectively. The field visits were used to conduct interviews with stakeholders and experts, and to gain a better understanding of the project context. The required data for conducting the assessment is selected from the collected data and organized to increase the ease of assessment of the project. In order to reduce the biases as result of misinterpretation of the assessment procedure, the relevant instructions are carefully read and a meeting with E. Cohen-Shacham, one of the main authors of the IUCN Standard, is held. After these preparatory steps, the assessment tool of the IUCN Standard is applied to the three case studies. A more elaborate analysis of the assessment procedure and the content of the IUCN Standard is provided in section 3.2.1. During the case study assessments, records are made of the challenges faced in applying the IUCN Standard.

The case study results are analysed to identify their potential added value to stakeholders (i.e., to whom are they useful and why), where stakeholders refer to people involved in the case studies, as well as people working on NbS through different ways. This reflection is supported by means of literature research and an interview with a project expert concerning their thoughts on the added value to them, the project team and relevant stakeholders. The research results are compared for the three case studies, providing insight into the challenges in application of the IUCN Standard to case studies and the added value that this application provides to stakeholders, thereby answering the third sub-question. For clarification, an overview of the methodology of the case study assessments is provided in Figure 2.2.

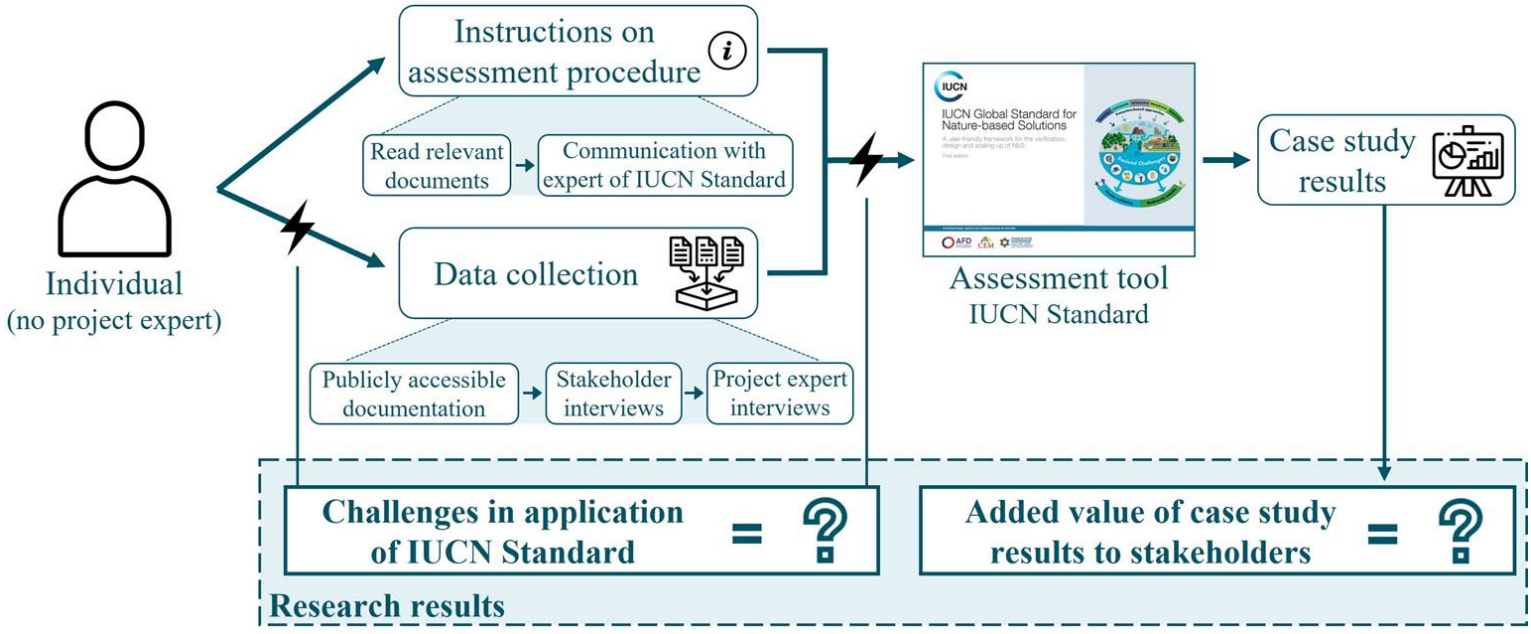


*Figure 2.2 – Methodology of case study assessments*

# 3. Relation IUCN Standard and other frameworks

This chapter covers the relation between the IUCN Standard and other assessment frameworks for NbS, identifying the shortcomings and benefits of the standard relative to other frameworks. Section 3.1 consists of an inventory and analysis of relevant assessment frameworks for NbS. In section 3.2, the IUCN Standard is analysed and general insights are provided on its scope and intended use in relation to the other frameworks. Lastly, specific insights on the shortcomings and benefits of the IUCN Standard are provided through in-depth comparisons with three of the most relevant frameworks in section 3.3.

## 3.1 Assessment frameworks for NbS

The literature research for relevant assessment frameworks for NbS, meeting the requirements established in section 2.1, yielded an inventory of twenty-two frameworks, which is given in Table 3.1.

*Table 3.1 – Inventory of assessment frameworks for NbS.*

| Framework number | Author, year of publication | Project / Organization |
|---|---|---|
| 1. | Sowińska-Świerkosz & García, 2021 | University of Life Sciences in Lublin |
| 2. | Shah et al., 2020 | OPERANDUM project |
| 3. | Calliari et al., 2019 | GREEN project |
| 4. | Pagano et al., 2019 | NAIAD project |
| 5. | Le Coent et al., 2021 | NAIAD project |
| 6. | Raymond et al., 2017 | EKLIPSE project |
| 7. | Watkin et al., 2019 | RECONECT project |
| 8.1 | Dumitru & Wendling, 2021 – Chapter 1 - 5 | European Commission |
| 8.2 | Dumitru & Wendling, 2021 – Chapter 6 | European Commission |
| 9. | Giordano et al., 2020 | NAIAD project |
| 10. | Autuori et al., 2019 | PHUSICOS project |
| 11. | Croeser et al., 2021 | Urban GreenUP project |
| 12. | Andrikopoulou, 2020 | Delft University of Technology - Rijkswaterstaat |
| 13. | Pudar, 2021 | University of Belgrade |
| 14. | Ruangpan et al., 2021 | RECONECT project |
| 15. | Graveline et al., 2017 | NAIAD project |
| 16. | Coletta et al., 2021 | NAIAD project |
| 17. | Wishart et al., 2021 | World Bank |
| 18. | Martens, 2017 | University of Groningen |
| 19. | Vojinovic et al., 2017 | PEARL project |
| 20. | Ommer et al., 2022 | OPERANDUM project |
| 21. | Huthoff et al., 2018 | Interreg North Sea Region (NSR) BwN project |

The identified assessment frameworks have differences in scope and intended use. To begin with, the frameworks are designed to be used in different phases of the project, distinguishing ex-ante, operational and ex-post. As all of the frameworks that explicitly mention to be designed for application in the operational phase are also designed to be used for ex-post assessment, the simplification that the operational phase is covered under the term “ex-post” is made for the remainder of the report. Furthermore, the frameworks differ with respect to the type of data input that is required, for which a distinction between quantitative, qualitative (incl. semi-quantitative) and a combination of quantitative and qualitative input is made. The distribution of the frameworks for the project phase in which they are

designed to be used and the type of input that is required are presented by means of pie-charts in Figure 3.1a and b, respectively. With regard to the scope of application, the frameworks have differences in the variety of societal challenges and types of area to which they are designed to be applicable.

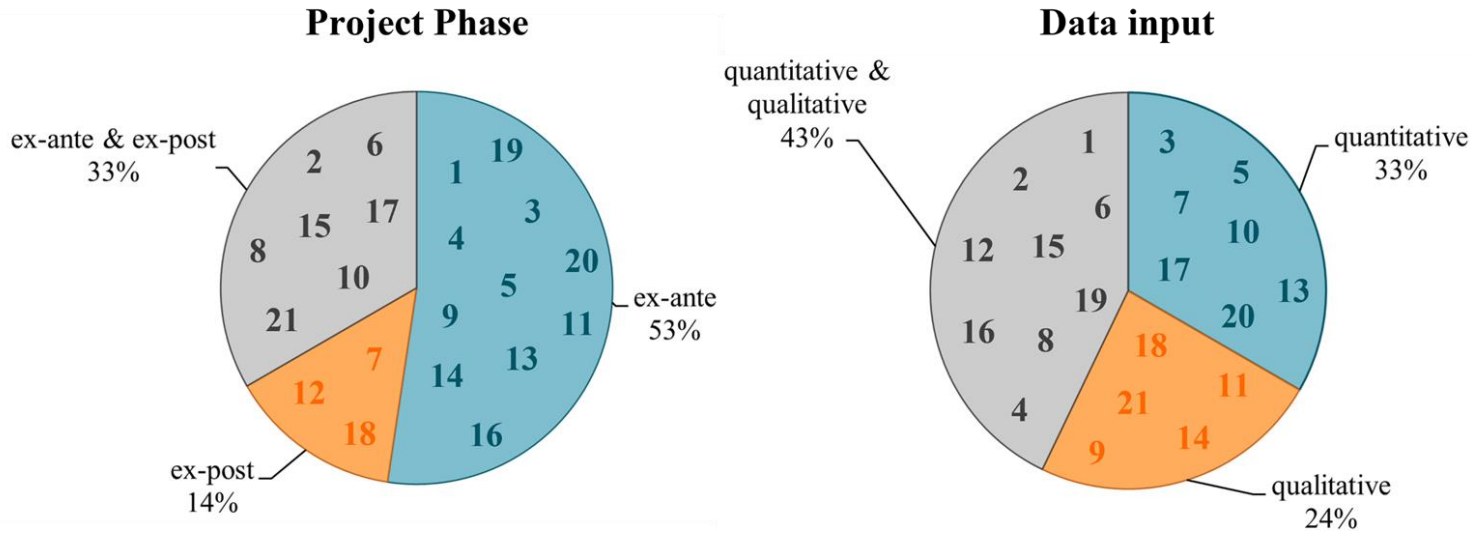


*Figure 3.1 – Distribution of assessment frameworks for (a) project phase, (b) data input type, presented by means of pie-charts in which the frameworks are indicated with the numbers in the corresponding pieces of the graphs.*

Out of the twenty-two assessment frameworks, seven frameworks mention the UN SDGs of which five frameworks include the contribution of the project to the SDGs in the assessment procedure. Furthermore, about half of the frameworks have mentioned or referenced a publication by the IUCN, of which one framework *(nr.2 – Shah et al., 2020)* claims to have a direct link with the IUCN definitional framework (Cohen-Shacham et al., 2016) and one framework *(nr.8.1 – Dumitru & Wendling, 2021)* claims to have a direct link with the IUCN Standard. The differences in scope and intended use, and the links with the UN SDGs and IUCN for the inventory of frameworks are provided in Table 3.2.

*Table 3.2 – Differences in scope and intended use, and connections with UN SDGs and IUCN for the inventory of frameworks.*

| Framework number | Project phase | Input type | Scope: societal challenges | Scope: area | Link UN SDGs | Link IUCN |
|---|---|---|---|---|---|---|
| **1.** | ex-ante | quantitative & qualitative | variety of challenges* | no limitation | not mentioned | reference to IUCN Standard |
| **2.** | ex-ante & ex-post | quantitative & qualitative | HMH[6] risk-reduction | no limitation | not mentioned | direct link to IUCN publication |
| **3.** | ex-ante | quantitative | variety of challenges* | no limitation | not mentioned | reference to IUCN |
| **4.** | ex-ante | quantitative & qualitative | flood risk mitigation | no limitation | not mentioned | reference to IUCN |
| **5.** | ex-ante | quantitative | water-related risk-reduction | no limitation | not mentioned | not mentioned |
| **6.** | ex-ante & ex-post | quantitative & qualitative | variety of challenges** | urban | not mentioned | reference to IUCN |
| **7.** | ex-post | quantitative | variety of challenges* | no limitation | not mentioned | not mentioned |

[6] HMH is the abbreviation of 'hydrometeorological hazard'.

| | | | | | | |
|---|---|---|---|---|---|---|
| **8.1** | ex-ante & ex-post | quantitative & qualitative | variety of challenges* | urban | direct link | direct link to IUCN Standard |
| **8.2** | ex-ante & ex-post | quantitative & qualitative | HMH risk-reduction | no limitation | direct link | direct link to IUCN Standard |
| **9.** | ex-ante | qualitative | HMH (climate-related) risk-reduction | no limitation | not mentioned | not mentioned |
| **10.** | ex-ante & ex-post | quantitative | HMH risk-reduction | rural - mountaineous | direct link | reference to IUCN |
| **11.** | ex-ante | qualitative | variety of challenges** | urban | not mentioned | not mentioned |
| **12.** | ex-post | quantitative & qualitative | riverine flood risk mitigation | riverine | direct link | reference to IUCN |
| **13.** | ex-ante | quantitative | flood risk mitigation | rural | not mentioned | not mentioned |
| **14.** | ex-ante | qualitative | HMH risk-reduction | no limitation | mentioned - no link | not mentioned |
| **15.** | ex-ante & ex-post | quantitative & qualitative | HMH risk-reduction | basin or (peri)urban | not mentioned | reference to IUCN |
| **16.** | ex-ante | quantitative & qualitative | water-related risk-reduction | no limitation | not mentioned | not mentioned |
| **17.** | ex-ante & ex-post | quantitative | flood risk mitigation | urban | mentioned - no link | reference to IUCN |
| **18.** | ex-post | qualitative | water-related risk-reduction | no limitation | not mentioned | not mentioned |
| **19.** | ex-ante | quantitative & qualitative | flood risk mitigation | no limitation | not mentioned | not mentioned |
| **20.** | ex-ante | quantitative | HMH risk-reduction | no limitation | direct link | reference to IUCN |
| **21.** | ex-ante & ex-post | qualitative | water-related risk-reduction | no limitation | not mentioned | not mentioned |

* Including all of the seven societal challenges recognized by the IUCN, as provided in Figure 1.2b.
** Excluding at least one of the societal challenges recognized by the IUCN, as provided in Figure 1.2b.

The inventory of assessment frameworks is presented by means of a graph in Figure 3.2. The x-axis of the graph represents the flexibility of the framework, which is defined as the flexibility in assessment of a project that is provided to the user. Frameworks that consist of a fixed amount of indicators without the possibility of selecting the indicators that are relevant to the project context (i.e., tailoring) provide a small flexibility in assessment to the user and are therefore positioned to the left of the graph. On the other extreme, there are frameworks that leave decisions on the elements to be evaluated and the valuation itself open to the interpretation of stakeholders. These frameworks provide a lot of flexibility in assessment and are therefore positioned to the right of the graph. The exact flexibility of the individual assessment frameworks can be found in Appendix A.

The y-axis of the graph represents the broadness of the framework, which, for this specific research, is defined as the broadness in scope of application with regard to the variety of societal challenges to which the framework is designed to be applicable. This definition implies that the broadness of the framework does not include the type of area (e.g., urban) to which the framework is designed to be applicable. Additionally, Figure 3.2 displays the project phase in which the framework is designed to be used and the type of data input that is required.


*Figure 3.2 – Graphical representation of the inventory of assessment frameworks for NbS, in which the IUCN Standard (thicker outline) is included based on the information provided in section 3.2.*

The graphical representation provided in Figure 3.2 allows to make the following conclusions with regard to the inventory of assessment frameworks for NbS:

(i) The assessment frameworks with a relatively large flexibility (*positioned on the right side of the graph)* are designed for ex-ante (*plus-signs*) applications only.
(ii) All of the frameworks with a fixed list of indicators, without tailoring possibilities (*positioned on the extreme left of the graph*) solely require qualitative and/or semi-quantitative input (*blue*).
(iii) Framework nr. 12 (i.e., Andrikopoulou, 2020) covered a gap of frameworks that have fixed indicators and a focus on (riverine) flood risk mitigation (*bottom left of the graph is uncovered*).
(iv) None of the frameworks that require stakeholder meetings and workshops as part of the assessment (*positioned on the extreme right of the graph*) solely require quantitative input (*red*).

## 3.2 IUCN Global Standard for NbS

The development and content of the IUCN Standard are described in section 3.2.1. Subsequently, the scope and intended use of the IUCN Standard, as well as the link with the UN SDGs are analysed and compared to the inventory of assessment frameworks for NbS in section 3.2.2.

### 3.2.1 Development and content of the IUCN Standard

The IUCN Standard was developed in response of the "pressing need for greater clarity and precision of what the concept entails and what is required for it to be deployed succesfully" (IUCN, 2020a, p. 2). Through the development of the IUCN Standard, the IUCN aims to achieve that NbS will be based on a common understanding of its interpretation and a shared vision for a just and sustainable world. Most of the framing of the IUCN Standard originates from the IUCN definitional framework for NbS (Cohen-Shacham et al., 2016), which is based on a whole range of ecosystem-related approaches. A subsequent research by Cohen-Shacham et al. (2019) found that the IUCN definitional framework can be considered as an umbrella framework for a series of well-established ecosystem-based and -related approaches

when a number of key identified gaps would be incorporated. Being a two-year process, the IUCN Standard was already being developed when this research was published. After incorporation of the identified gaps and two rounds of public consultations with more than 800 responses from 100 countries, the IUCN Standard was published in July 2020 (IUCN, 2020b; IUCN, 2019).

The IUCN Standard consists of eight criteria, listed in Table 3.3, which are the essential principles to which a (design of a) project must adhere in order to qualify as a NbS, according to the IUCN Standard.

*Table 3.3 – Criteria of the IUCN Global Standard for NbS (IUCN, 2020a).*

| | |
|---|---|
| **Criterion 1** | NbS effectively address societal challenges. |
| **Criterion 2** | Design of NbS is informed by scale. |
| **Criterion 3** | NbS result in a net gain to biodiversity and ecosystem integrity. |
| **Criterion 4** | NbS are economically viable. |
| **Criterion 5** | NbS are based on inclusive, transparent and empowering governance processes. |
| **Criterion 6** | NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits. |
| **Criterion 7** | NbS are managed adaptively, based on evidence. |
| **Criterion 8** | NbS are sustainable and mainstreamed within an appropriate jurisdictional context. |

Each criterion is composed of three to five indicators, adding up to twenty-eight indicators in total. The indicators represent different components of the criteria and function as guiding principles for design or qualitative parameters for evaluation. Examples of indicators of the IUCN Standard are as follows:

> **Criterion 3 – Indicator 2 (i.e., Indicator 3.2):** "*Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed"* (IUCN, 2020a, p. 10).

> **Indicator 7.2:** "*A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle"* (IUCN, 2020a, p. 18).

The full list of indicators of the IUCN Standard is provided in Appendix B. The document at the foundation of the IUCN Standard is the user-friendly framework (IUCN, 2020a), which is supplemented with an in-depth guidance (IUCN, 2020b) and a self-assessment tool. An overview of the three documents with a brief description of their contents is provided in Figure 3.3.

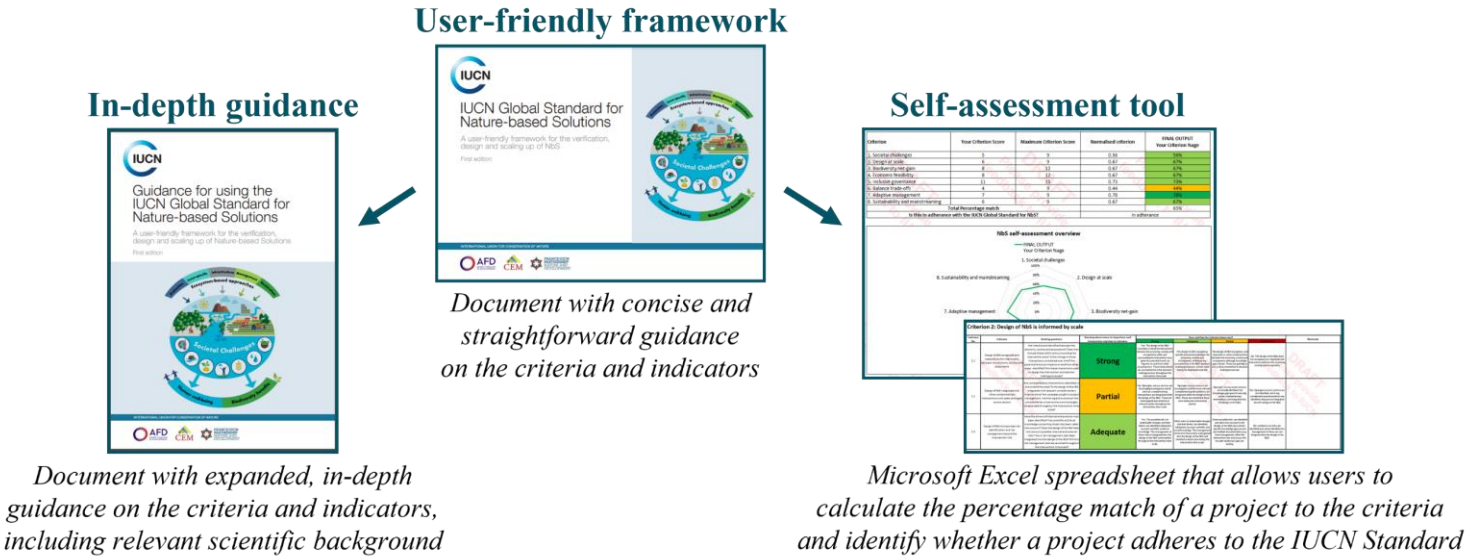


*Figure 3.3 – Overview and description of the three documents of the IUCN Global Standard for NbS.*

The IUCN Standard states that it supports users to (1) enable purposeful design of a solution adhering to the criteria and indicators, or (2) assess whether a (potential) project adheres to the criteria and indicators of the IUCN Standard. For this second purpose, the self-assessment tool has been developed. This tool consists of a set of three to eight guiding questions for each indicator, which represent different components of the element that is evaluated by the indicator. These guiding questions enable users to identify and score the extent (*strong, adequate, partial or insufficient*) to which a project adheres to the individual indicators. Examples of guiding questions of indicator 7.2 are as follows:

*"Is there a robust monitoring and evaluation plan in place?"*

*"Is it being implemented throughout the lifecycle of the intervention?"*

The full list of guiding questions, accompanied with guidance for selecting the appropriate scores, is provided in Appendix B for each of the indicators. In addition, the self-assessment tool allows the user to add rationale to the provided scores. The indicator scores are used to calculate the level of adherence to each of the criteria, of which the output consists of a percentage match of the project to the criterion, a rating and a traffic light colour, as indicated in Table 3.4.

*Table 3.4 – Output of self-assessment tool for each of the criteria (IUCN, 2020b).*

| Percentage match (%) | Rating | Traffic light colour |
|---|---|---|
| ≥ 75 | Strong | |
| ≥ 50 & < 75 | Adequate | |
| ≥ 25 & < 50 | Partial | |
| < 25 | Insufficient | |

The deliverables of an assessment with the self-assessment tool, which follow from the percentage match of the project to each of the criteria, can be separated into the following three types of results:

**1 - Total percentage match and adherence to the IUCN Standard**

Within the self-assessment tool, the percentage match of the project to each criterion is normalized such that each criterion has an equal weight. Subsequently, the normalized percentage match for each of the eight criteria is averaged, resulting in a total percentage match of the project to the IUCN Standard. In addition, the self-assessment tool provides a statement on whether the project adheres to the IUCN Standard, for which a requirement is put at a percentage match of at least twenty-five percent to each criterion. Therefore, a project can have a high total percentage match to the IUCN Standard (e.g., 80 - 90 percent), but not be in adherence to the standard if it has a lower than twenty-five percent match to just one of the criteria. With regard to ex-post assessments, the IUCN Standard states: *"past and ongoing NbS that predate the development of this Standard can also be evaluated against the Standard's Criteria, if the intention is for the intervention to be recognized as an NbS"* (IUCN, 2020b, p. 11). This implies that a project that is in adherence to the IUCN Standard, following from an ex-post assessment, can be recognized (i.e., qualifies) as a NbS according to the norm of the IUCN Standard.

**2 – Strenghts and weaknesses**

The indicators of the IUCN Standard consist of guiding questions that represent different components of the element that is evaluated by the indicator, as clarified with examples above. For the remainder of this report, the components of the indicators (i.e., guiding questions) that a project is and is not in line with are defined as "strengths" and "weaknesses" of the project. If a project is in line with all of the guiding questions of an indicator, it has a "strong" match to the indicator, solely revealing strenghts of the project. Whereas a "partial" match to an indicator reveals both strenghts and weaknesses of a project.

**3 – Radar chart**

The third type of result, following from assessment with the self-assessment tool, is a radar chart that represents the percentage match of a project to each of the eight criteria of the IUCN Standard.

### 3.2.2 Analysis of the IUCN Standard

Analysis of the scope and intended use of the IUCN Standard, as well as the link with the UN SDGs, allows to relate the standard to the inventory of frameworks established in section 3.1, providing general insights on shortcomings and benefits of the standard. The IUCN Standard is intended to be used by anyone working on the verification, design and scaling up of NbS. Examples of envisioned users are national, city and local governments, planners, businesses, donors, financial institutions and non-profit organisations. As the IUCN Standard targets users working on projects at different stages, it is designed for ex-ante and ex-post applications. All of the criteria and indicators of the IUCN Standard are fixed and require to be completed for each assessment, which implies that there are no possibilities to exclude indicators that are not relevant (i.e., tailoring) and therefore limited flexibility in assessment is provided to the users. As covered in section 3.2.1, evaluation of the indicators of the IUCN Standard requires a score out of four options (i.e., semi-quantitative input). This is in line with finding (ii) in section 3.1 that frameworks with a fixed list of indicators solely require qualitative and/or semi-quantitative input.

With regard to the scope of application, there are no limitations to the type of area and scale to which the IUCN Standard is designed to be applicable. Furthermore, the IUCN Standard recognizes seven societal challenges, as provided in Figure 1.2b, with the possibility for other challenges to be recognized as NbS evolves in their scope. The knowledge that the IUCN Standard consists of fixed indicators without tailoring possibilities (i.e., limited flexibility) and is designed to be applicable to a wide variety of societal challenges, positions the standard in the top left of the graphical representation of the inventory of frameworks in Figure 3.2. Lastly, the IUCN Standard consists of a link with the UN SDGs through indicator 8.3, which is defined as follows:

> **Indicator 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)"* (IUCN, 2020a, p. 20).

When using the IUCN Standard for assessment of a project, this indicator evaluates whether a project has identified relevant national and global targets, such as the UN SDGs, and whether the contribution to these targets is reported to the relevant platforms. Therefore, the IUCN Standard evaluates the link between a project and the UN SDGs, but not its actual contribution to the SDGs. The positioning of the IUCN Standard in Figure 3.2 and the additional information regarding its intended use, scope and link with the UN SDGs provides the following conclusions with regard to the shortcomings and benefits of the IUCN Standard in relation to the inventory of assessment frameworks for NbS:

- The IUCN Standard has a **broad scope of application**, as it is applicable to a variety of societal challenges, types of area, scales and project phases, and its use does not require expert knowledge. Being broadly applicable is a benefit of the IUCN Standard, but may pose a shortcoming in the assessment of projects in specific sectors as result of its broad language and guidance.

- The IUCN Standard provides **limited flexibility** in assessment to its users by not providing the possibility to tailor the assessment to the project context. When using the IUCN Standard as prescribed, this might pose a challenge in its application to different contexts, making it a shortcoming of the standard. On the other hand, the exclusion of criteria and indicators, which the IUCN recognizes as essential principles of NbS, is prevented. Completion of all criteria and indicators allows for statements as the "total percentage match to the IUCN Standard" and "recognition as a NbS" as deliverables of assessment with the IUCN Standard. These statements might be of added value to stakeholders and are therefore a benefit of the IUCN Standard.

- The IUCN Standard is **descriptive**, as it solely requires semi-quantitative input with optional qualitative rationale. A benefit of descriptive (i.e., qualitative and/or semi-quantitative) data is that it is generally easier to collect than quantitative data. Descriptive data also has several disadvantages relative to non-descriptive, quantitative data. To begin with, a shortcoming of the IUCN Standard is that a semi-quantitative assessment is susceptible to human errors. For an assessment with quantitative input, which inherently requires exact rationale (e.g. measurements),

different users would end up with similar results, while for an assessment with semi-quantitative input, which is influenced by the interpretation and bias of the user, different users are likely to end up with significantly different results. As replication of the assessment would not produce the same results, the assessment cannot be tested or checked, making the results of assessment with the IUCN Standard less reliable and more open to arguments than a quantitative assessment, which is a shortcoming of the standard. Furthermore, a shortcoming of the IUCN Standard is that descriptive deliverables generally provide less credibility to a project than quantitative deliverables, such as a percentage of flood risk reduction or an amount of species recovered.

- The IUCN Standard has a **link with the UN SDGs** through indicator 8.3, which is a benefit of the standard as it promotes monitoring and reporting of the contributions of a project to the SDGs. However, it does not evaluate the actual contributions to the SDGs, which, relative to frameworks nr. 8, 10, 12 and 20, is a shortcoming of the IUCN Standard.

## 3.3 Comparison IUCN Standard and frameworks

In this section, the general insights on the shortcomings and benefits of the IUCN Standard, provided in the previous section, are complemented with more specific insights related to the content of the standard. These insights are obtained through in-depth comparison of the IUCN Standard to the following three frameworks that meet the requirements and wishes established in section 2.1: (1) Andrikopoulou (2020), (2) Dumitru & Wendling (2021) and (3) Huthoff et al. (2018). These assessment frameworks are described and elaborately compared with the IUCN Standard to identify shortcomings (i.e., key elements that are missing) and benefits (i.e., key elements that users would benefit from) of the standard in sections 3.3.1 to 3.3.3. A summary of the most significant shortcomings and benefits of the IUCN Standard that follow from the comparisons is provided in section 3.3.4.

### 3.3.1 Comparison with framework – Andrikopoulou, 2020

The first assessment framework for NbS to which the IUCN Standard is compared is the framework by Andrikopoulou (2020), which is titled "*Nature Based Solutions for fluvial flood mitigation: An integrated assessment framework"*. The framework was developed as part of a master thesis at the Delft University of Technology in collaboration with Rijkswaterstaat. Its development was initiated in response of an identified lack of an assessment framework which both establishes a direct link to the UN SDGs and assesses the technical performances of a NbS project. Next to providing these two elements, the framework is designed for assessment of the performances of NbS projects for fluvial flood mitigation. The in-depth comparison of the IUCN Standard with the framework by Andrikopoulou (2020) is divided into (i) the scope and intended use, and (ii) the deliverables, after which the shortcomings and benefits of the IUCN Standard relative to the framework are listed.

#### Scope and intended use – Andrikopoulou, 2020

The framework by Andrikopoulou (2020) is composed of 5 stages, 15 themes and 52 indicators, which are designed for ex-post assessment to benchmark, measure, compare and reflect on the characteristics and performances of a project. The indicators require a combination of qualitative and quantitative input. Furthermore, the framework provides the flexibility to exclude the themes and indicators that are irrelevant to the project context (i.e., tailoring). With regard to the scope of application, the framework is restricted to (i) riverine areas, (ii) projects with a focus on flood risk reduction and (iii) developing countries. The fixed list of indicators with tailoring possibilities and restriction to riverine flood risk reduction positions the framework by Andrikopoulou (i.e., framework nr. 12) in the bottom left of Figure 3.2. Therefore, the framework has a small broadness in scope of application and limited flexibility relative to the inventory of frameworks. The discussion of the thesis by Andrikopoulou (2020) covers speculations on adjustments to the framework to change its scope, such that it can be used for (i) ex-ante assessments (*changing the square in Figure 3.2 to a circle*) and (ii) a larger variety of societal challenges (*moving the framework higher up in Figure 3.2*). This suggests that changes to the content of a framework may allow to alter its position and shape in the graphical representation in Figure 3.2.

Twenty-one out of the fifty-two framework indicators are linked to the Sustainable Development (SD) indicators of ten UN SDGs, which allows users to evaluate the contribution of a project to the linked SDGs. A subsequent research by Andrikopoulou et al. (2021) extends the framework with an even more elaborate evaluation of the contribution of a project to the UN SDGs and the UN 2030 Agenda. Furthermore, the framework by Andrikopoulou (2020) cites the NbS definition by the IUCN and refers to the seven societal challenges recognized by the IUCN, but does not include a link to the IUCN Standard. To summarize, the scope, intended use and links to the UN SDGs and IUCN are provided for the IUCN Standard and the framework by Andrikopoulou in Table 3.5.

*Table 3.5 – Scope, intended use and links to the SDGs and IUCN for the IUCN Standard and the framework by Andrikopoulou.*

| Characteristics | IUCN Standard | Framework – Andrikopoulou, 2020 |
|---|---|---|
| **Project phase** | ex-ante & ex-post | ex-post |
| **Input type** | semi-quantitative | qualitative and quantitative |
| **Scope: societal challenge** | variety of societal challenges | (riverine) flood risk mitigation |
| **Scope: area** | no limitation | riverine; developed world |
| **Link UN SDGs** | (limited) link | direct (and strong) link |
| **Link IUCN** | published by IUCN | reference to definitional framework |
| **Flexibility** | fixed indicators, without tailoring | fixed indicators, with tailoring |

**Deliverables – Andrikopoulou, 2020**

The main deliverables of an assessment with the framework by Andrikopoulou (2020) are as follows:

- A conclusion on whether flood risk reduction and other project objectives have been achieved.
- An overview of the benefits, co-benefits, costs and trade-offs of the project.
- An overview of the contribution to ecosystem services and the UN SDGs.
- A clear and concise overview with metadata for the indicators of the five stages.

A comparison of the deliverables of the framework by Andrikopoulou and the deliverables of the IUCN Standard, which are provided in section 3.2.1, reveals a significant difference between the frameworks: the IUCN Standard can exclusively be used to evaluate the processes throughout a project, while the framework by Andrikopoulou can exclusively be used to evaluate the results of a project. This is reflected by the deliverables, where the IUCN Standard provides an overview of the extent to which the essential processes of a NbS (i.e., criteria and indicators), as established by the IUCN, have been incorporated in a project, while the framework by Andrikopoulou provides an overview of the project performances, as listed above. Processes that are evaluated by the IUCN Standard include, among others, risk management, targeting and monitoring, stakeholder engagement, iterative learning and adaptive management. The difference between both frameworks can be clarified with the following indicators:

> **IUCN Standard – Indicator 5.3:** *"Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention"* (IUCN, 2020a, p. 14).
>
> **Framework by Andrikopoulou – Process:** *"Number of different stakeholders/disciplines involved"* (Andrikopoulou, 2020, p. 96).

Where the indicator of the IUCN Standard evaluates whether stakeholders have been identified and involved in the project (i.e., project processes), the indicator of the framework by Andrikopoulou evaluates the amount of involved stakeholders (i.e., project results). In the remainder of this report, this difference between the evaluation of processes or results by an assessment framework is defined as:

- **process-oriented** for an assessment framework that can be used to evaluate the processes throughout a project (e.g., IUCN Standard).
- **results-oriented** for an assessment framework that can be used to evaluate the results of a project (e.g., Andrikopoulou, 2020).

Other terminologies used in literature to refer to these type of frameworks and indicators consist of "solutions-oriented" (Dumitru & Wendling, 2021a) and "reflection on design and implementation steps" (Huthoff et al., 2018) for process-oriented frameworks, and of "impact evaluation" (Dumitru & Wendling, 2021a), "performance indicators" (Andrikopoulou, 2020; Huthoff et al., 2018) and "success indicators" (Huthoff et al., 2018) for results-oriented frameworks. Furthermore, the terms "process-oriented" and "results-oriented" are not to be confused with "objectives-based management" and "results-based management", which refer to management approaches with an emphasis on achieving objectives and results, respectively (Taljaard et al., 2011). Whether an assessment framework is process-oriented or results-oriented does not put a restriction to the phase of the project to which it is applicable.

It should be noted that the IUCN Standard does include a few excepts in which the guiding questions, depending on how these are interpreted, can be used to evaluate project results. One of the guiding questions of indicator 5.3 that demonstrates the possibility to evaluate project results is as follows:

*"Do affected stakeholders accept and feel ownership over the outcomes of the intervention?"*

This specific guiding question can be used to evaluate the process of involving affected stakeholders and ensuring that they feel connected to the project, but it can also be used to evaluate the result of whether affected stakeholders accept and feel ownership of the project. The same applies to five to ten of the more than two hundred guiding questions of the self-assessment tool of the IUCN Standard. Therefore, with only a few excepts, the IUCN Standard cannot be used for the evaluation of project results, referring to both biophysical, and social, institutional and stakeholder outcomes.

**Shortcomings and benefits of the IUCN Standard – Andrikopoulou, 2020**

The differences in intended use, scope and deliverables, together with further comparison of the contents of the IUCN Standard and the framework by Andrikopoulou allow for the identification of shortcomings and benefits of the IUCN Standard relative to the framework, which are listed in Table 3.6.

*Table 3.6 – Shortcomings and benefits of the IUCN Standard relative to the framework by Andrikopoulou (2020).*

| Shortcoming/Benefit of the IUCN Standard | Description |
|---|---|
| **Difference:** Process-oriented vs Results-oriented | The IUCN Standard is process-oriented and the framework by Andrikopoulou is results-oriented. |
| **Shortcoming:** No insight into project results | The IUCN Standard does not provide insight into project results, while this would be valuable to demonstrate its effectiveness and provide credibility to the project. |
| **Shortcoming:** No evaluation of objectives | The IUCN Standard cannot be used to evaluate whether the project objectives are met or not. |
| **Shortcoming:** No insight into contribution to ecosystem services or UN SDGs | Application of the IUCN Standard does not provide insight into the contribution of the project to ecosystem services and the UN SDGs. |
| **Benefit:** Evaluation of project processes | The IUCN Standard can be used to evaluate whether essential processes of a NbS, as recognized by the IUCN, have been incorporated throughout the project. |
| **Difference:** Broadness – scope of application | The IUCN Standard is designed to be applicable to a wide variety of projects, while the framework by Andrikopoulou is restricted to riverine flood mitigation in the developed world. |
| **Shortcoming:** No sector-specific topics | *Similar to finding in section 3.2.* The framework by Andrikopoulou includes indicators for the evaluation of riverine flood mitigation. The IUCN Standard does not include sector-specific topics, which may pose a challenge in interpreting the (broad) guidance for sector-specific contexts. Furthermore, it results in a less in-depth assessment. |

| | |
|---|---|
| **Benefit:** Broader applicability | *Similar to finding in section 3.2.* |
| **Difference:** Data input type | The IUCN Standard requires semi-quantitative data and the framework by Andrikopoulou requires a combination of both qualitative and semi-quantitative data input. |
| **Shortcoming:** Susceptible to human errors | *Similar to finding in section 3.2.* |
| **Shortcoming:** Deliverables are less reliable and more open to arguments | *Similar to finding in section 3.2.* |
| **Shortcoming:** Deliverables generally provide less credibility to a project | *Similar to finding in section 3.2.* |
| **Benefit:** Easier data collection | *Similar to finding in section 3.2.* |

| | |
|---|---|
| **Shortcoming:** Missing topics in IUCN Standard | The IUCN Standard does not include criteria and/or indicators that consider: (i) the impact of climate change and (ii) technical elements (e.g., structural integrity and resilience). |
| **Benefit:** Designed for ex-ante application | In contrast to the framework by Andrikopoulou, the IUCN Standard is also designed for ex-ante application, providing guidance for design and enabling the evaluation of design. |
| **Benefit:** Incorporation of stakeholder input in the assessment | Indicators of the IUCN Standard refer to stakeholder experiences, allowing for stakeholder input in the assessment, while the framework by Andrikopoulou does not. Involving stakeholders in the assessment might be beneficial to the communication and collaboration with stakeholders. |
| **Benefit:** Support of an international institution | Where the framework by Andrikopoulou is the product of a master thesis, the IUCN Standard is supported by an international institution and is therefore likely to be widely used. The IUCN Standard therefore has the potential to provide a wide body of experience on its application. |
| **Benefit:** Periodic updates | The documents of the IUCN Standard are its first edition reports. These documents are to be revised prior to each IUCN World Conservation Congress, which is held once every four years (E. Cohen-Shacham, personal communication, June 21, 2022). The benefit of such a "living document" is that the periodic updates can be used to keep the IUCN Standard up-to-date with the changing world and the resultant impact on how NbS are understood and used, as well as with feedback provided by users of the standard. The framework by Andrikopoulou does not mention periodic updating and is therefore at risk of becoming out-dated. |

### 3.3.2 Comparison with framework – Dumitru & Wendling, 2021

Next, the IUCN Standard is compared to the handbook by Dumitru & Wendling (2021a), which is titled "*Evaluating the Impact of Nature-based Solutions: A Handbook for Practitioners".* Chapter 1 to 5 and Chapter 6 of the handbook consist of two separate assessment frameworks, which for the purpose of this research are defined as "framework nr. 8.1" and "framework nr. 8.2", respectively. Furthermore, the handbook is complemented with an appendix of methods by Dumitru & Wendling (2021b). The development of the handbook was part of the European Union's (EU) research and innovation funding program Horizon 2020 (H2020), which consists of more than twenty projects that directly adress NbS and closely related themes. Several frameworks identified in section 3.1 are products of H2020 projects: OPERANDUM, NAIAD, EKLIPSE, RECONECT and PHUSICOS. The handbook was developed by members of Task Force 2 of H2020, whose collaborative effort aimed at establishing a dynamic NbS impact evaluation framework that is based on the collective experience acquired through execution of

prior H2020 NbS projects. The in-depth comparisons of the IUCN Standard with the frameworks by Dumitru & Wendling (2021a) are divided into (i) the scope and intended use, and (ii) the deliverables, after which the shortcomings and benefits of the IUCN Standard relative to the frameworks are listed.

**Scope and intended use – Dumitru & Wendling, 2021**

Framework nr. 8.1 builds on and expends the framework by Raymond et al. (2017) (i.e., framework nr. 6 in section 3.1), which is a product of the EKLIPSE project. The framework is divided into twelve societal challenge areas, which each consist of a fixed list of indicators from which the ones relevant to the project context can be selected (i.e., tailored). In addition, the framework distinguishes between recommended and additional indicators. The indicators require quantitative, qualitative or semi-quantitative input and can be used for both ex-ante and ex-post applications. With regard to the scope of application, the frameworks is restricted to urban context and recognizes a variety of twelve societal challenges, complementing the framework by Raymond et al. (2017) with two additional challenges. This positions the framework in the top left of Figure 3.2, which implies that it has a broad scope of application and limited flexibility relative to the inventory of frameworks. Framework nr 8.2 extents the framework to catchment scale, including both rural mountaineous and coastal areas, and focuses on the societal challenge of disaster risk reduction. The framework is composed of guidance on the selection and use of the frameworks by (i) Shah et al. (2020) (i.e., framework nr. 2), (ii) Watkin et al. (2019) (i.e., nr. 7), (iii) Autuori et al. (2019) (i.e., nr. 10) and (iv) Graveline et al. (2017) (i.e., nr. 15). This provides flexibility in assessment to the user, which together with the focus on disaster risk reduction, positions the framework in the middle of Figure 3.2. Therefore, framework nr. 8.2 has an average broadness in scope of application and an average flexibility relative to the inventory of frameworks.

All of the indicators of framework nr. 8.1 are linked to the UN SDGs in the appendix by Dumitru & Wendling (2021b), while from the frameworks mentioned in framework nr. 8.2 only the one by Autuori et al. (2019) consists of a link to the SDGs. Furthermore, even though framework nr 8.1 claims to be strongly aligned with the criteria and indicators of the IUCN Standard, it is not clear how this has been incorporated into the indicators and methodology. From the frameworks mentioned in framework nr 8.2, only the one by Shah et al. (2020) has a direct link to a publication by the IUCN. To summarize, the scope, intended use and links to the UN SDGs and IUCN are provided for the IUCN Standard and the frameworks by Dumitru & Wendling (2021a) in Table 3.7.

*Table 3.7 – Scope, intended use and links to the SDGs and IUCN for the IUCN Standard and frameworks nr. 8.1 and 8.2.*

| Characteristics | IUCN Standard | Framework 8.1 (Ch 1 – 5) | Framework 8.2 (Ch 6) |
|---|---|---|---|
| **Project phase** | ex-ante & ex-post | ex-ante & ex-post | ex-ante & ex-post |
| **Input type** | semi-quantitative | quantitative & qualitative | quantitative & qualitative |
| **Scope: societal challenge** | variety of societal challenges | variety of societal challenges | disaster risk reduction |
| **Scope: area** | no limitation | urban | catchment (incl. coastal and rural mountaineous) |
| **Link UN SDGs** | direct link | direct link | - |
| **Link IUCN** | published by IUCN | direct link (claimed; not clear in practice) | - |
| **Flexibility** | fixed indicators, without tailoring | fixed indicators, with tailoring (recommended & additional indicators) | guidance on indicator selection (with elaborate reference to frameworks) |

**Deliverables - Dumitru & Wendling, 2021**

The frameworks provided by Dumitru & Wendling (2021a) can exclusively be used to evaluate the results of a project and are therefore results-oriented. In ex-ante applications, the frameworks can be

used to identify potential benefits and use these to inform design. By reviewing the list of indicators, the user is able to identify and select potential benefits and results that one would like to achieve with the NbS project. The selected indicators can help to establish throughtful objectives and design, and are therefore valuable for monitoring the performances during later stages of the project. When used for ex-post assessment, framework nr. 8.1 provides the following main deliverables:

- An overview of results: (O) accomplishments or impacts, (P) procedures employed to achieve the desired goals and (S) infrastructure and resources in place to achieve the desired goals.
- A conclusion on whether the project objectives have been met.
- An overview of the effectiveness of the project (comparison baseline data and results).
- A list of SDGs to which the project has contributed.

The deliverables of framework nr. 8.2 are dependent on the assessment framework that is selected, but are generally in line with the deliverables of framework nr 8.1.

**Shortcomings and benefits of the IUCN Standard – Dumitru & Wendling, 2021**

The differences in intended use, scope and deliverables, together with further comparison of the contents of the IUCN Standard and frameworks nr. 8.1 and nr. 8.2 allow for the identification of shortcomings and benefits of the IUCN Standard relative to the frameworks, which are listed in Table 3.8.

*Table 3.8 – Shortcomings and benefits of the IUCN Standard relative to the frameworks by Dumitru & Wendling (2021a).*

| Shortcoming/Benefit of the IUCN Standard | Description |
|---|---|
| **Difference:** Flexibility in assessment | The IUCN Standard consists of a fixed list of indicators, without tailoring possibilities, while the frameworks by Dumitru & Wendling support the user to independently design the framework. This returns in practice for framework nr. 8.1 by providing a "buffet-style" list of indicators from which the relevant ones can be selected and for framework nr 8.2 by providing guidance on the selection and use of frameworks. |
| **Shortcoming:** Potential challenge in application to different project contexts | *Similar to finding in section 3.2.* |
| **Benefit:** Provision of statements such as the "total percentage match to IUCN Standard" | *Similar to finding in section 3.2.* |
| **Difference:** Process-oriented vs Results-oriented | |
| **Shortcoming:** No insights into project results | *Similar to finding in section 3.3.1.* |
| **Benefit:** Evaluation of project processes | *Similar to finding in section 3.3.1.* |
| **Difference:** Process-oriented vs Results-oriented for ex-ante applications | Ex-ante application of the IUCN Standard (process-oriented) can be used to (i) guide design on the entire project cycle or (ii) evaluate which essential processes of NbS have been incorporated in design. Ex-ante application of the frameworks by Dumitru & Wendling (results-oriented) can be used to identify potential benefits and use these to inform design. |
| **Shortcoming:** No examples of benefits | As the IUCN Standard does not consist of results-oriented indicators, it does not contain examples of potential benefits or contributions that can be achieved with the NbS project. |
| **Benefit:** Guidance on design and evaluation | The IUCN Standard provides elaborate guidance on the entire project management cycle and can be used to evaluate whether all essential processes of a NbS are incorporated in a design. |

| | |
|---|---|
| **Difference:** Broadness – scope of application | The IUCN Standard is designed to be applicable to a variety of projects, while the frameworks by Dumitru & Wendling are restricted to urban areas and disaster risk reduction |
| **Shortcoming:** No sector-specific topics | *Similar to finding in sections 3.2 and 3.3.1.* Two of the twelve societal challenge areas included in framework nr. 8.1 are not covered by the societal challenges and/or criteria of the IUCN Standard: "Green space management" & "Place regeneration", which are urban-specific challenges. As the IUCN Standard does not include sector-specific challenges, it provides a less in-depth assessment. |
| **Benefit:** Broader applicability | *Similar to finding in sections 3.2 and 3.3.1.* |

| | |
|---|---|
| **Shortcoming:** Limited guidance on resources for evaluation | The appendix of methods by Dumitru & Wendling (2021b) provides guidance on possible resources (e.g., data collection and measurement methodologies) for completion of each individual indicator, which is likely to increase the ease of data collection. The IUCN Standard, on the other hand, provides very limited guidance on resources for evaluation. |
| **Benefit:** Few competences required of assessors | The frameworks by Dumitru & Wendling are designed for educated non-experts, as they require critical thinking for selection of the relevant indicators. The IUCN Standard does not require critical thinking for indicator selection, as the indicators are fixed, without tailoring possibilities. Therefore, assessment with the IUCN Standard requires less competences. |

### 3.3.3 Comparison with framework – Huthoff et al., 2018

The last assessment framework for NbS to which the IUCN Standard is compared is the framework by Huthoff et al. (2018), which is titled "*Evaluating Nature-Based Solutions – Best practices, frameworks and guidelines".* The framework was developed as part of the BwN project of the Interreg NSR Programme 2014-2020 of the European Union, which aimed to generate evidence-base and enlarge multidisciplinary knowledge about NbS for coasts and catchments (Giovanni & Zevenbergen, 2019). As part of this program, the objective of the developed assessment framework was to "create a 'preferred framework' for NbS, in order to compare and evaluate projects" (Huthoff et al., 2018, p. 2). The in-depth comparison of the IUCN Standard with the framework by Huthoff et al. is divided into (i) the scope and intended use, and (ii) the deliverables, after which the shortcomings and benefits of the IUCN Standard relative to the framework are listed.

#### Scope and intended use – Huthoff et al., 2018

Prior to the development of the framework, Huthoff et al. (2018) identified the following four essential elements for evaluation of NbS: efficiency (related to output), effectiveness (related to outcome), social support (related to process) and flexibility. These four elements compose the criteria of the framework, which each consist of three to six indicators. The indicators require semi-quantitative input with three options: the indicator is met (+1), the indicator is not met (0) and it is unclear if the indicator is met (+0.5). If used as intended, indicators that are not relevant to the project context should not be excluded (i.e., no tailoring), but instead be provided with a score of +0.5. With regard to the scope of application, the framework is restricted to (i) coasts and catchments, and (ii) water-related risk reduction. This positions the framework by Huthoff et al. (i.e., framework nr. 21) in the extreme left and at middle height in Figure 3.2, which implies that it has an average broadness in scope of application and a limited flexibility relative to the inventory of frameworks. Furthermore, the framework does not mention the UN SDGs and the IUCN. To summarize, the scope, intended use and links with the UN SDGs and IUCN are provided for the IUCN Standard and the framework by Huthoff et al. in Table 3.9.

*Table 3.9 – Scope, intended use and links to the SDGs and IUCN for the IUCN Standard and the framework by Huthoff et al.*

| Characteristics | IUCN Standard | Framework – Huthoff et al., 2018 |
|---|---|---|
| **Project phase** | ex-ante & ex-post | ex-ante & ex-post |
| **Input type** | semi-quantitative | semi-quantitative |
| **Scope: societal challenge** | variety of societal challenges | water-related risk reduction |
| **Scope: area** | no limitation | coasts and catchments |
| **Link UN SDGs** | (limited) link | not mentioned |
| **Link IUCN** | published by IUCN | not mentioned |
| **Flexibility** | fixed indicators, without tailoring | fixed indicators, without tailoring |

**Deliverables – Huthoff et al., 2018**

As part of the study by Huthoff et al. (2018), the framework is used for ex-post evaluation of three case studies. Similar to the IUCN Standard, the indicators are of reflective character and can be used to evaluate whether fundamental processes have been incorporated in a project, as demonstrated by the following indicator of the framework:

> **Framework by Huthoff et al. – Efficiency:** *"Have nature-friendly materials been used?"* (Huthoff et al., 2018, p. 24)

Only one indicator of the framework by Huthoff et al. can be used to evaluate the results of a project, which is defined as follows:

> **Framework by Huthoff et al. – Effectiveness:** *"Did monitoring show that the NbS answered the objective?"* (Huthoff et al., 2018, p. 24)

With the exception of this indicator, ex-post application of the framework can exclusively be used to evaluate the project processes and the framework is therefore defined as process-oriented. The deliverables of an ex-post evaluation with the framework consist of (i) an overall score (0 – 100 percent) to each of the criteria and (ii) identification of the indicators (i.e., fundamental elements of a NbS according to Huthoff et al.) to which a project does (not) comply. Even though the framework by Huthoff et al. does not explicitly mention ex-ante application, the indicators are comparable to those of the IUCN Standard and therefore have the potential to provide guiding principles for designing a (NbS) project and to be used for evaluation of a design. When using the framework for ex-ante applications, one should omit the indicator that evaluates whether monitoring has shown that the NbS answered the objective.

**Shortcomings and benefits of the IUCN Standard – Huthoff et al., 2018**

The differences in intended use, scope and deliverables, together with further comparison of the contents of the IUCN Standard and the framework by Huthoff et al. allow for the identification of shortcomings and benefits of the IUCN Standard relative to the framework, which are listed in Table 3.10.

*Table 3.10 – Shortcomings and benefits of the IUCN Standard relative to the frameworks by Huthoff et al. (2018).*

| Shortcoming/Benefit of the IUCN Standard | Description |
|---|---|
| **Difference:** Broadness – scope of application | The IUCN Standard is designed to be applicable to a wide variety of projects, while the framework by Huthoff et al. is restricted to water-related risk reduction. |
| **Shortcoming:** No sector-specific topics | *Similar to finding in sections 3.2, 3.3.1 and 3.3.2* |
| **Benefit:** Broader applicability | *Similar to finding in sections 3.2, 3.3.1 and 3.3.2* |
| **Shortcoming:** No evaluation of objectives | *Similar to finding in section 3.3.1.* Even though most of the indicators of the framework by Huthoff et al. are process-oriented, it includes one indicator that evaluates whether the |

| | |
|---|---|
| | project is answering the objectives, providing insight into the effectiveness of the project. The IUCN Standard does include whether certain outcomes (e.g., biodiversity) are periodically assessed, but does not evaluate whether the project actually answers the objectives (i.e., whether it is actually effective). |
| **Shortcoming:** No evaluation of targets & monitoring for project objectives | The framework by Huthoff et al. includes an indicator that evaluates whether "success indicators" (i.e., targets to monitor project performance) are defined at the start of the project. The IUCN Standard includes similar indicators that evaluate whether targets and monitoring are established for human well-being and biodiversity conservation, but falls short at evaluating whether targets/indicators and monitoring are established for other challenges that are targeted by the project. |
| **Benefit:** More advanced semi-quantitative input | The IUCN Standard provides more options (four) for evaluation than the framework by Huthoff et al. (three). Generally, four options provide users with a better tool to evaluate the extent to which a project meets the indicators, while users are likely to select the middle option when in doubt and having only three option. In addition, the traffic-light colour-system of the IUCN Standard allows for easier interpretation of the results. |

### 3.3.4 Summary of in-depth comparisons

The in-depth comparisons of the IUCN Standard with the assessment frameworks by Andrikopoulou (2020), Dumitru & Wendling (2021a) and Huthoff et al. (2018) complement the shortcomings and benefits identified in section 3.2.2 with more specific insights on the content of the IUCN Standard. The most significant shortcomings and benefits of the IUCN Standard relative to the three frameworks are listed in Table 3.11. Together, the shortcomings and benefits of the IUCN Standard that follow from its relation to the inventory of frameworks and from the in-depth comparisons point out the points of attention for its application to case studies. The identified shortcomings and benefits of the IUCN Standard are verified by the results of the case study assessments in section 6.1.

*Table 3.11 - Shortcomings and benefits of the IUCN Standard relative to the three most relevant frameworks.*

| Shortcoming/Benefit of the IUCN Standard | Description | Section |
|---|---|---|
| **Shortcoming:** No insight into project results | The IUCN Standard cannot be used to evaluate the results (i.e., effectiveness) of a project. | 3.3.1 & 3.3.2 |
| **Shortcoming:** No sector-specifc topics | The IUCN Standard does not include sector-specific topics, which may pose a challenge in application. | 3.3.1, 3.3.2 & 3.3.3 |
| **Shortcoming:** Limited guidance on resources for evaluation | The IUCN Standard provides limited guidance on resources (e.g., data collection & measurement methods) for completion of the indicators. | 3.3.2 |
| **Shortcoming:** No evaluation of targets & monitoring for project objectives | Except for human well-being and biodiversity objectives, the IUCN Standard cannot be used to evaluate whether targets/indicators & monitoring are established for the objectives of a project. | 3.3.3 |
| **Benefit:** Evaluation of project processes | The IUCN Standard is process-oriented, which means that it can be used to evaluate the processes throughout a project. | 3.3.1 & 3.3.2 |
| **Benefit:** Incorporation of stakeholder input in the assessment | The IUCN Standard allows for the incorporation of stakeholder input in the assessment of a project. | 3.3.1 |
| **Benefit:** Few competences required of assessors | Assessment with the IUCN Standard requires relatively few competences. | 3.3.2 |

# 4. Features of river restoration projects

This chapter consists of a selection of the most relevant features, based on which river restoration projects can be classified and a categorization of types of riverine NbS measures, which are preceding steps to the case study selection in section 5.1. First, an inventory of a wide variety of physical and non-physical features is established in sections 4.1 and 4.2, respectively. Subsequently, section 4.3 covers the selection of the five features that are most significant in classifying river restoration projects. Lastly, the types of riverine NbS measures are classified into five categories in section 4.4.

## 4.1 Physical features of river restoration projects

The literature research for features, based on which river restoration projects can be classified yielded a non-exhaustive inventory of physical features of river restoration projects, which is provided below. Most of the identified features are indicated in a graphical representation of a catchment in Figure 4.1.

- Surface area
- Position in the catchment
- Kinetic energy of the river
- Geology
- Landforms
- Land cover
- Land use
- Existing interventions
- Biodiversity
- Climate

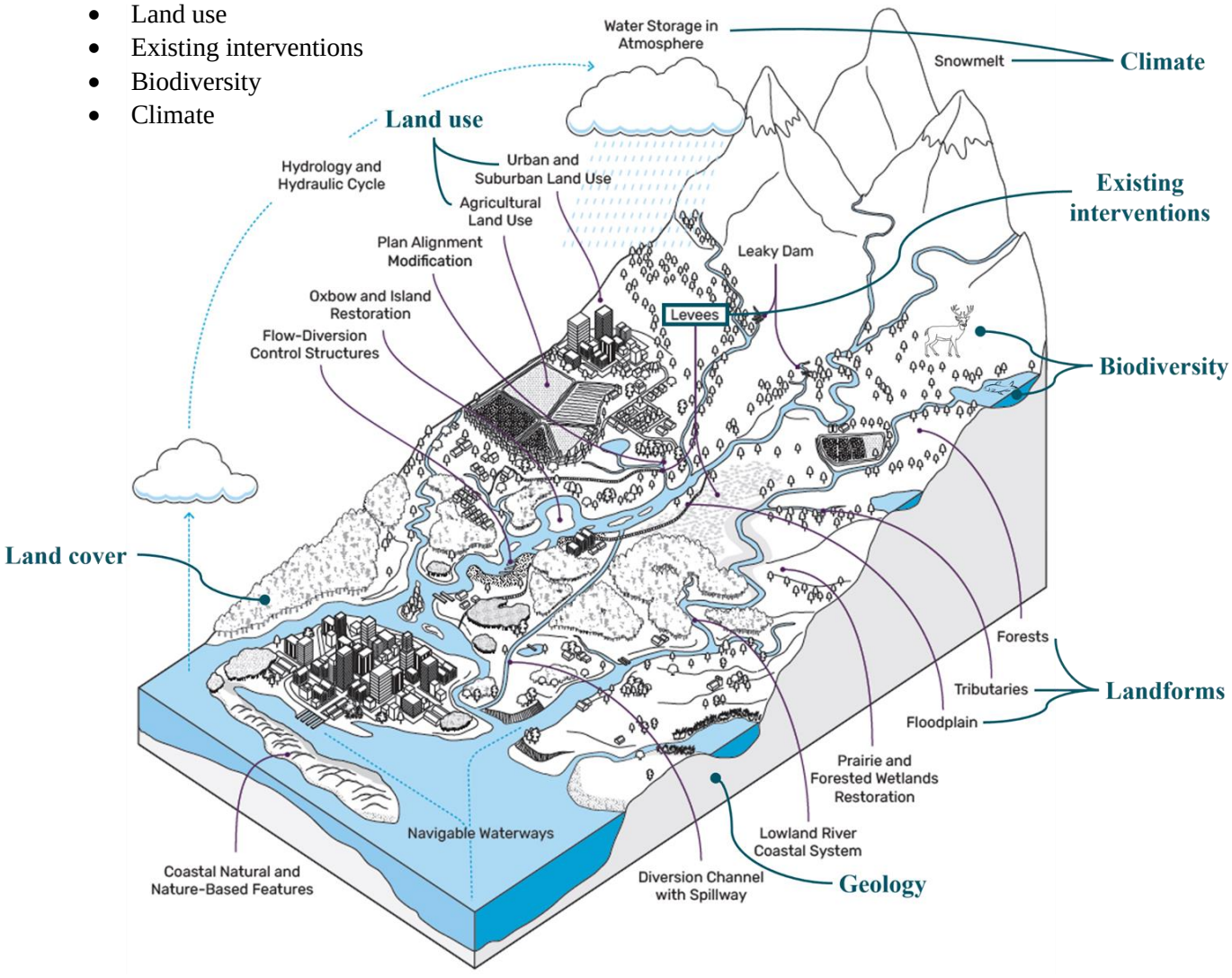


*Figure 4.1 – A catchment with indication of physical features of river restoration projects (in green) (Bridges et al., 2021a).*

Each of the physical features, based on which river restoration projects can be classified that is included in the inventory is defined and provided with the relevant context below.

**Surface area**

An important element, based on which river restoration projects, as well as projects in general, can be classified is the scale of the project. There are various features that can be used to describe the scale of a project with examples as the project costs, duration and number of people involved (Brink & Settlemire, 2016). The provided examples are covered in the inventory of non-physical features in section 4.2. A physical feature that can be used to demonstrate the scale of a project, thereby classifying different river restoration projects, is the surface area. For the remainder of this report, a distinction is made between (i) the surface area of the NbS measures and (ii) the surface area of the (sub)catchment in which the project is located. Both are represented in square kilometers.

The surface area of the NbS measures refers to the availability of free space for the implementation of NbS measures, which has a direct influence on the measures that can be implemented. For instance, the planting of trees requires a lot smaller surface area than the reconnection of a river with its floodplains. When a project that has completed the implementation phase (ex-post) is considered, the surface area of NbS measures is defined as the surface area of the measures that have been implemented. The surface area of the (sub)catchment in which the project is located is also an important feature of river restoration projects. Catchments (i.e., watersheds) comprise numerous natural features and physical processes that together regulate the flow of water, sediments and nutrients throughout the system. Therefore, the catchment scale should be considered when planning and designing infrastructure for flood risk mitigation in fluvial systems (Bridges et al., 2021a).

**Position in the catchment**

The position of the project in the catchment can be categorized into upper, middle and lower catchment, each indicated with their main characteristics in Figure 4.2. This position has an influence on the effectiveness of different types of NbS measures. In the upper catchment, it is typically effective to slow down the river flow, which can be achieved by measures that increase flood storage or infiltration, or that partially block the flow. By storing and retaining water, peak discharges downstream can be delayed and reduced in magnitude. Furthermore, retaining the water on the floodplains in the upper catchment is beneficial to sediment management, allowing for fine sediment deposition and nutrient cycling, which decreases potential morphological and water quality problems downstream (Bridges et al., 2021a).

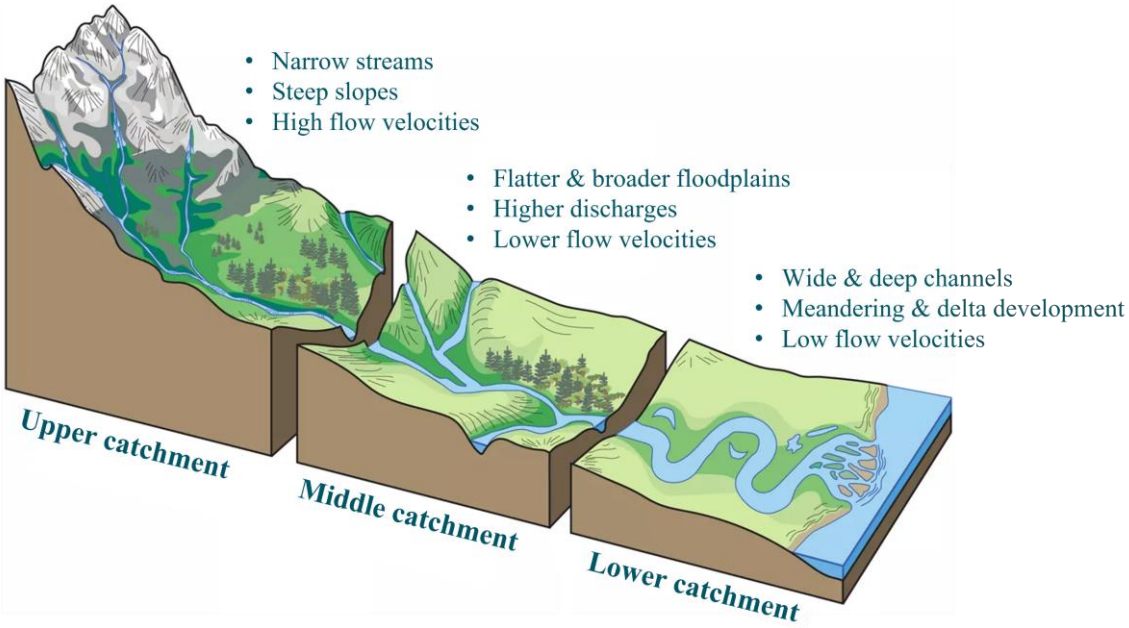


*Figure 4.2 – River catchment divided into upper, middle and lower catchment (Thornberry-Ehrlich, n.d.).*

As result of the added discharge from tributaries, the discharges in the middle and lower catchment are larger than in the upper catchment. Furthermore, rivers in the middle and lower catchment are often restricted by levees and their floodplains are heavily built upon. In contrast to the upper catchment, it is therefore generally not effective to slow down the river flow. Instead, it is typically effective to increase the discharge capacity and thereby reduce the floodwater levels. This can, for instance, be achieved by providing the river with additional space through floodplain reconnection (Bridges et al., 2021a).

**Kinetic energy of the river**

The kinetic energy of the river is the energy possessed by the river as result of being in motion (Jain, 2009). Considering moving fluids, the kinetic energy is typically expressed as the kinetic energy per unit volume, represented by equation 4.1 (Nave, 2017).

$$\frac{E_k}{V} = \frac{\frac{1}{2} * m * v^2}{V} = \frac{\rho * v^2}{2} \qquad (4.1)$$

Where:
- $E_k$ = kinetic energy of the fluid [J]
- V = volume of the fluid [$m^3$]
- m = mass of the fluid [kg]
- v = velocity of the fluid [m/s]
- ρ = density of the fluid [$kg/m^3$]

Equation 4.1 indicates that the kinetic energy per unit volume is a function of the density and velocity of the river. The density of river water is dependent on various factors, such as the concentration of suspended sediment, water temperature and salinity (Van Rooijen et al., 2020), and the velocity of the river is influenced by the slope, roughness and shape of the channel (Gierke, 2002). As the difference in the density of rivers is typically relatively small, for a rough approximation, it is assumed that the respective kinetic energy per unit volume of rivers can be represented by the flow velocities.

The kinetic energy of a river is related to the sediment transport capacity, which Xiao et al. (2017) defined as "the maximum load of sediment that a given flow rate can carry". The sediment transport capacity is positively correlated with the river discharge Q (= m * V). This implies that a river with a larger velocity and/or volume (i.e., higher kinetic energy) has a larger sediment transport capacity. When the sediment load from upstream is below the sediment transport capacity, there is net erosion. Therefore, a river with a higher kinetic energy will have erosion more often and with larger magnitudes[7].

As result of its influence on the sediment transport capacity, the kinetic energy of a river influences the effectiveness of NbS measures. For clarification, a river restoration project in the upper catchment is considered, which makes it typically effective to hold back and store water. Various measures can be implemented to achieve this, of which the selection depends on, among others, the available surface area. When a medium amount of surface area is available, an effective NbS measure to hold back water may be to (re-)meander the river. (Re-)meandering, however, is not effective when the kinetic energy of the river is high, as this results in a large sediment transport capacity, which makes it likely that the river banks erode, moving the meanders and making it an ineffective measure. Instead, an effective NbS measure to slow down a river flow with high kinetic energy, which requires a medium amount of surface area, may be the construction of retention basins. An overview of which riverine NbS measures are typically effective dependent on the position in the catchment, surface area and kinetic energy is given by means of a flowchart in Figure 4.3. As there are many other factors that influence the effectiveness of NbS measures, of which several are discussed in this chapter, this flowchart is solely meant to illustrate the implications that these features have on the effectiveness of NbS measures. Similar efforts of splitting up NbS measures that are typically effective for different features of the riverine area exist in literature with examples as Figure 2.6 by Forbes et al. (2015) and Table 1 by Dadson et al. (2017).

[7] An exception to this conclusion are cases in which the larger kinetic energy is solely a result of a larger density.

* If **very high up in the catchment** (e.g., headwater streams in mountaineous alpine watersheds), at locations with steep slopes, **small available surface area** and rivers with **high kinetic energies**, any structure is likely to be washed away and effects of NbS measures are generally hardly noticeable downstream (Bridges et al., 2021a).

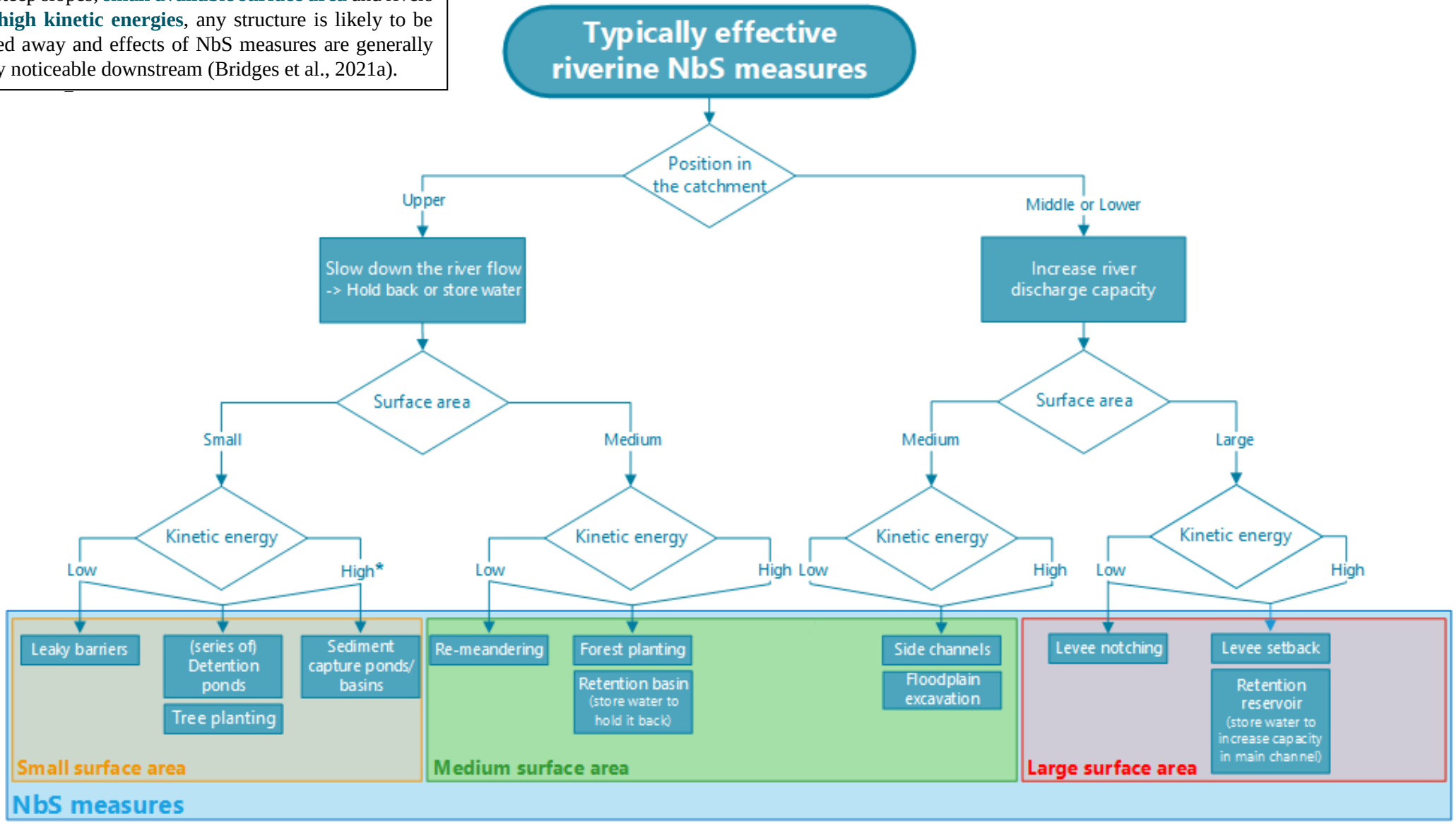


*Figure 4.3 - Flowchart of the influence of the position in the catchment, surface area and kinetic energy of the river on the effectiveness of riverine NbS measures*

## Geology

The geology of the project area can be defined as the types of rocks and minerals that are present within the area, together with their structure and distribution (Zohar, 2016). It determines the amount of water that can be retained in the area and thereby the magnitude and speed of the run-off. Through this principle, the geology of the project area has an influence on the effectiveness of different NbS measures. For permeable geologies, it is typically effective to implement measures that encourage infiltration, such as the planting of trees. In areas where the geology is less permeable, it can be effective to divert run-off (e.g., using cross drains or bunds) to areas where water can be retained, such as in ponds. For impermeable geologies, solely measures that slow down the overland flow are likely to be effective (Wren et al., 2022). The influence of the geology of an area on infiltration and run-off does not only determine the effectiveness of NbS measures, but also what happens during floods, thereby characterizing different types of riverine areas. In addition, the geology of the project area influences the rate of river erosion. The erosion rate of a river with a river bed made of hard rock will be smaller than one with a river bed made of soft rock (Internet Geography, n.d.-a). Through the erosion of the river bed and banks, the geology also has an influence on the composition of sediment in the river.

## Landforms

Cooke et al. (2014) defined a landform as "a naturally formed feature on the Earth's surface, having a characteristic shape or form". Examples of landforms in fluvial landscapes are oxbow lakes and deltas, which are illustrated in Figure 4.4. Prior to many rivers being channelized, the riverine environment was dynamic with a large diversity of landforms. This diversity has been largely lost since the channelization of rivers (Wolfert, 2001). The landforms currently present at a riverine area can therefore be used to characterize the dynamics of a riverine environment. The riverine landscape setting and its landforms are an important consideration in the design of a river restoration project, as materials and measure types should be selected to complement the setting and integrate the landforms (Wren et al., 2022).

*Figure 4.4 – (a) Oxbow lake in the Amazon River, South America (BBC, n.d.);*
*(b) River delta in Puget Sound, State of Washington, United States of America (Jones, 2018).*

## Land cover

The land cover at the project area, which Lambin et al. (2001) defined as the "biophysical attributes of the earth's surface", refer to vegetation types, soils, exposed rocks and water bodies, as well as anthropogenic elements, such as built environments and agriculture (ABARES, n.d.). In assessing flood susceptibility, the land cover is a crucial factor. Areas with less vegetation are relatively more prone to flooding as a result of less infiltration, where urban areas that are covered with impervious surfaces, resulting in significant run-off and limited storage, are at even higher risk of flooding (Rahman et al., 2021). The land cover is connected to the features "land management", which often determines the type of land cover, and "geology", which also has a large influence on the run-off and storage of water.

### Land use

The land use (i.e., land management) at the project area can be defined as the socio-economic description of the project area. Examples of different land use types are using an area for residential, industrial, recreational or agricultural purposes (European Environment Agency, 2004). The land use at the project area is closely related to the land cover, as it often determines the type of land cover. It should, however, be considered as a seperate feature, because a certain type of land cover, such as agricultural land, can be used for many different land use types, like intensive versus extensive agriculture and poorly drained versus heavily drained agriculture. Research has shown that changes in land use can lead to an increase in runoff and erosion, modification of flow regimes and enhancement of transport of nutrients, sediments and contaminants. The land use, therefore, has a significant impact on the characteristics of the riverine area and the type of river restoration measures that are effective to be implemented (Cooper et al., 2013).

### Existing interventions

For the remainder of this report, existing interventions are defined as any river-related interventions in the project area that have been implemented prior to the river restoration project. Examples of existing interventions are levees and bridges. The type, size and amount of interventions have an important influence on the flood dynamics in the project area. Furthermore, if an existing interventions breaks, breaches or fails, this can result in the blockage of a structure (e.g., a bridge) or flooding. These risks have to be accounted for in the design of a river restoration project (Wren et al., 2022).

### Biodiversity

The biodiversity at the project area refers to the diversity of plant and animal species in the habitat(s) at the project area and may result in various constraints and opportunities for river restoration projects (Verma, 2017). When, for instance, protected species and/or habitats are present in the project area, this has to be accounted for in measure design (e.g., fish passage), materials used (e.g., tree species that support the endangered species) and implementation (e.g., no disturbance during fish spawning). On the other hand, when the diversity of species is degrading or lower than expected, this provides opportunities to target these specific species for restoration. The constraints and opportunities as a result of biodiversity influence the NbS measures that should be selected for a project, having an impact on the final result of a river restoration project (Wren et al., 2022).

### Climate

The climate at the project area is defined as the long-term pattern of weather conditions at the project area. With regard to the climate of an area, scientists look at averages of precipitation, temperature, humidity, sunlight, wind velocity and other measures of the weather that occur over a long period in a particular place (NASA, 2017). The climate has an influence on the effectiveness of certain NbS measures, such as measures that incorporate living vegetation and therefore require sufficient duration and intensity of sunlight. Furthermore, it has an influence on the river processes and landscapes in the project area. The amount of precipitation, for instance, influences the erosion rates, sediment transport and extent of chemical weathering[8], where high temperatures can lead to increased chemical weather as well (Wren et al., 2022; Internet Geography, n.d.-b).

[8] Chemical weathering is defined by Macheyeki et al. (2020) as “the interaction of rocks with mineral solutions (chemicals) to change the composition of rocks”.

## 4.2 Non-physical features of river restoration projects

The literature research for features, based on which river restoration projects can be classified also yielded the following non-exhaustive inventory of non-physical features of river restoration projects:

- Data accessibility
- Resources
- Stakeholder engagement
- River functions
- Institutional context
- Political borders
- Fit between bio-geophysical and institutional system
- Focus of project leaders and main partnerships

Each of the non-physical features is defined and provided with the relevant context below.

### Data accessibility

River restoration projects can be characterized by the data availability and accessibility, which can be defined as the "existence" and "possibility and ease of retrieval" of data, respectively (Dumitru & Wendling, 2021a). In this case, data refers to all types of project-related data, including project reports, monitoring data and communication logs. The amount of monitoring data that is available indicates the extent to which project interventions are monitored and therefore the extent to which the project outcomes can be quantified and monetized. In addition, data availability in general influences the extent to which iterative learning and adaptive management can be applied successfully. The accessibility of this data plays an important role in the transferability of the knowledge gained in the project.

### Resources

The main types of resources in project management can be divided into financial, time, human and material resources (actiTIME, 2021). Therefore, resources are defined as the amount of funds, time, people and material goods that is available to dedicate to the project. A lack of resources is a constraint on the completion of a project and may therefore limit its success. Furthermore, the amount of available resources for a project is an important consideration in the selection of the NbS measures to be implemented. For instance, certain funding streams may solely be available for a specific type of measure and the materials goods that are available for the project may not be suitable for the implementation of certain measures (Wren et al., 2022).

### Stakeholder engagement

The stakeholder engagement at the project is defined as the process used by the project leaders or organization to engage relevant stakeholders to achieve the agreed objectives. It includes how stakeholders are involved to identify, understand and respond to issues and concerns, and how stakeholders are engaged in decisions and actions (AccountAbility, 2015). Working together with stakeholders allows for a collaborative design that combines local knowledge, data and technical expertise. A project that is delivered by such a collaborative approach is likely to be more succesful in meeting its objectives than a project with limited stakeholder engagement (Wren et al., 2022).

### River functions

River functions can be defined as all human activities that take place on the river or interact with its water. Examples are transportation by shipping (Figure 4.5a), extraction for drinking water or irrigation in agriculture, production of electricity through hydroelectric dams (Figure 4.5b) and leisure activities, such as swimming (National Geographic Society, 2022). The functions of the river influence the types of NbS measures that can be applied and therefore also the type of river restoration project. For instance, when a river is used for shipping or boating, it is not a viable solution to place logs in the river.

*Figure 4.5 – (a) Shipping on the Rhine-Main-Danube Canal in Bavaria, Germany (Suntinger, 2020); (b) Hydroelectric dam in Slovenia (National Geographic Society, 2022).*

### Institutional context

The institutional context at the project is defined as the rules, regulations, policies and cultural factors that apply for the project and project area (Sinem, 2021). The rules and regulations to manage land to control flood risk differ throughout the world (Bridges et al., 2021a). As mentioned in section 1.1.3, these varying regulatory frameworks can be a substantial barrier to successful implementation of NbS. Examples of differences in the institutional context that influence the implementation of NbS measures are landownership policies and the extent to which it is acknowledged that NbS provide multiple benefits that grey solutions do not (Schielen et al., 2020). Furthermore, dependent on the institutional context, certain locations or NbS measures may require specific permissions (Wren et al., 2022). To conclude, the institutional context of a project can result in significant implications for the type and amount of NbS measures that can be applied and therefore certainly influences the type of river restoration project.

### Political borders

The political borders of the project area refer to the borders between countries, states, provinces and/or municipalities within the project area. The presence of political borders within a project area results in the need for transboundary cooperations and joint-decision making, as well as a larger number of stakeholders that have to be taken into account. Furthermore, political borders within the project area can imply that different institutional contexts need to be acknowledged. All of these processes may form restrictions for river restoration projects and require additional resources, which may have an influence on the design and implementation processes of river restoration projects.

### Fit between bio-geophysical and institutional system

The fit between the bio-geophysical[9] and institutional system at the project is known to influence the effectiveness of institutions working on river restoration projects through the restoration of floodplains. Spatial (mis)fits can occur when the project area that is covered by the institutions does (not) geographically match with the bio-geophysical system, resulting in the institutions (not) being able to internalize relevant effects from outside of the project area. In addition, temporal (mis)fits can occur when the project lifetime, which for river restoration projects is typically relatively short, does (not) correspond to the dominant time scales in the bio-geophysical system. These misfits are considered as major limitations to successful implementation of river restoration projects and the extent to which these misfits occur can therefore be used to characterize river restoration projects (Vreugdenhil et al., 2010).

[9] Bio-geophysical refers to the biological, geological and physical processes operating in an area, such as the physical properties of the land surface (e.g., roughness) (Law Insider, n.d.).

**Focus of project leaders and main partnerships**

The focus of the project leaders or organization and main partnerships has an influence on the type of river restoration project that they deliver. To clarify, in case the project leaders and their main partnerships have a broad focus with a wide variety of objectives, the result is likely to be a multi-benefit integrated project. Whereas, project leaders and partnerships that solely have an eye for flood risk mitigation will most likely produce a river restoration project where the type and locations of the measures have been selected for optimal contribution to flood risk mitigation.

## 4.3 Most relevant features of river restoration projects

As the case study selection in section 5.1 is based on the most relevant features, based on which river restoration projects can be classified, a selection of the five most relevant features from the inventories in sections 4.1 and 4.2 is provided in Table 4.1.

*Table 4.1 – Most relevant features, based on which river restoration projects can be classified.*

| Features | Physical / Non-physical |
|---|---|
| Surface area | physical |
| Position in the catchment | physical |
| Kinetic energy of the river | physical |
| Data accessibility | non-physical |
| Resources | non-physical |

The rationale for selection of each of the features is provided below.

**Surface area**

As stated in section 4.1, this research distinguishes the surface area of the NbS measures and the surface area of the (sub)catchment in which the project is located. The surface area that is available for the implementation of NbS measures (ex-ante) or on which NbS measures have been implemented (ex-post) has an impact on, among others, the costs of the project, the amount of stakeholder involved, the implications due to institutional context and the complexity of design, implementation and monitoring. Furthermore, the surface area that is available for the implementation of measures is a boundary condition for the type, amount and size of the NbS measures that can be implemented.

The surface area of the (sub)catchment in which the project is located has an influence on the types of NbS measures that should be implemented for a river restoration project to be effective in reducing flood risk. In a catchment with a large surface area, such as the Mississippi River catchment, NbS measures with a relatively small effect on flood risk (e.g., detention ponds) will not make a noticeable impact on catchment scale. Therefore, NbS measures that may achieve a larger effect on flood risk (e.g., large-scale floodplain reconnection) are typically more suitable to reduce flood risk in a catchment with a large surface area. On the other hand, NbS measures with a smaller effect, such as retention ponds, may be very effective in reducing flood risk in a catchment with a smaller surface area, in which the surface area that is available for measures might also be smaller and not suitable for large-scale measures. To conclude, the surface area of the NbS measures and the (sub)catchment both have a significant impact on the measures to be implemented, as well as on other elements of river restoration projects, making the surface area a relevant feature in classifying river restoration projects.

**Position in the catchment and Kinetic energy of the river**

Together, the position of a project in the catchment and the kinetic energy of the river have a significant impact on the effectiveness of different types of NbS measures, as illustrated in Figure 4.3. Assuming that the project is designed in an effective manner, its position in the catchment and the kinetic energy of the river have a significant influence on the methods and measures applied at a river restoration project. Therefore, both are selected as most relevant features in classifying river restoration projects.

**Data accessibility**

Unlike the other features that are selected, the data availability and accessibility is not necessarily a feature that will have a large impact on the physical appearance of a river restoration project. However, it can potentially influence the amount of iterative learning, adaptive management and transfer of knowledge that is successfully applied at a project. More importantly, the data accessibility, which is defined as the ease of data retrieval, is likely to have an impact on the applicability of the IUCN Standard. As one of the main objectives of the research is to determine the applicability of the IUCN Standard, it is decided to include the data accessibility as one of the most relevant features. Application of the IUCN Standard to case studies, which as a result of this selection will differ in data accessibility, allows to gain valuable insights into the influence of data accessibility on the applicability of the IUCN Standard.

**Resources**

The amount of resources (i.e., funds, time, people and material goods) that are available to dedicate to the project have a significant impact on the design, implementation and monitoring of a river restoration project. As result, the project deliverables and outcomes in terms of contribution to societal challenges and provision of co-benefits are likely to be very different for a project with limited resources and one with a significant amount of resources. Therefore, the resources of a project is a very relevant feature in determining the type of river restoration project.

## 4.4 Types of riverine NbS measures

The types of NbS measures that are actually implemented in a river restoration project depend on many features, of which the main ones are included in the inventories in sections 4.1 and 4.2. As the definitive decision on which measures are actually implemented is made by individuals, it is not guaranteed that the most effective measures, taking into account all influencing factors, are selected. This implies that the types of NbS measures that are actually implemented in a project take place at a higher level in the characterization of river restoration projects than the individual features. Therefore, supplementary to the five features that are selected in section 4.3, the case study selection is based on the types of NbS measures that have actually been applied at the project.

For the purpose of this research, the most common types of NbS measures for river restoration purposes are classified into five categories. This categorization is based on classifications of river restoration measures that are established by Verdonschot et al. (2015), Speed et al. (2016) and Bridges et al. (2021a). A river restoration project can consist of measures from only one category of NbS measures, but it may also consist of measures from all of the five categories into which the types of NbS measures have been classified. The five categories, supported with two examples each, are as follows:

**A - Floodplain reconnection**

The reconnection of a river with its floodplains is used in river restoration to (i) reduce flood risk by increasing the discharge capacity, (ii) allow for the movement of species and sediments between the channel and floodplain, and (iii) increase the groundwater recharge and assimilation of pollutants (Speed et al., 2016). Examples of NbS measures that can be applied to reconnect the river with its floodplains are levee notching and the removal of hard-engineered riverbank protection.

**B – River planform adjustments**

There are various methods to adjust the river planform with examples as (re-)meandering and the reconnection of abandonded channels (e.g., oxbow lakes and paleochannels), as illustrated in Figure 4.6. By adjusting the planform, these measures decrease the slope of the channel and improve the lateral connectivity, which delays and decreases the flood peak, reducing downstream flood risk. In addition, adjustments to the river planform create new flow conditions and increase habitat heterogeneity, which has the potential to promote biodiversity conservation and recovery (Nagayama & Nakamura, 2017).

*Figure 4.6 – (a) Re-meandering of a straightened river at the Eddleston Water, Scotland (Spray, 2022); (b) Reconnection of oxbow lake to main channel at the Saône, France (NWRM, 2013).*

**C – Planting or removal of vegetation**

The planting of vegetation, both instream and riparian, is used in river restoration to promote and/or create habitats, supporting the biodiversity. Furthermore, revegetation of the riparian zone slows the run-off towards the channel and is capable of trapping sediments and pollutants (Speed et al., 2016). Another example of a NbS measure that fits within this category is the removal of invasive species that can lead to increased flood risk and the extinction of native species (Bridges et al., 2021a).

**D - In-channel interventions**

An example of an in-channel intervention is the removal or modification of in-channel hydraulic structures, such as weirs and dams. These relatively large interventions are used in river restoration to improve the river flow and enable the passage of sediments and fish (Speed et al., 2016). Adjustments to the operation of in-channel hydraulic structures, such as the release of environmental flows from dams described by Owusu et al. (2020) and Arthington (2012), are not within the scope of this study. Another example of an in-channel intervention is the engineering of leaky barriers (i.e., flow restrictors or log jams) to slow down the flow and store floodwaters, as illustrated in Figure 4.7 (Bridges et al., 2021a).

*Figure 4.7 – Leaky barrier at Flimby, England (Bridges et al., 2021b).*

**E – Interventions in the floodplain**

The last category concerns interventions in the floodplains of the river. An example of NbS measures in the floodplains are off-line storage areas (e.g., ponds or basins), which function to retain and attenuate floodwater in a managed way. Another NbS measure that fits into this category is floodplain excavation, which increases the discharge capacity and lowers the flood levels. In addition, the floodplains inundate more often, resulting in the deposition of sediments and nutrients (Bridges et al., 2021a).

The Room for the River Program in the Netherlands is a great example of successful implementation of interventions in the floodplain (category E) and floodplain reconnection (category A). As part of this program, Rijkswaterstaat, which is the executive agency of the Ministry of Infrastructure and Water Management in the Netherlands, has implemented measures at 30 locations to (i) increase the discharge capacity of the rivers such that they can cope with higher water levels and (ii) improve the spatial quality of the floodplains. Examples of measures that were implemented are dike replacements (category A), high-water channels (category E) and floodplain excavation (category E) (Rijkswaterstaat, n.d.-a).

# 5. Application of the IUCN Standard to case studies

This chapter consists of the ex-post assessment of three case studies with the IUCN Standard. The tool used for these assessments is the self-assesment tool of the IUCN Standard, of which the content and corresponding assessment procedure are described in section 3.2.1. In section 5.1, three case studies are selected based on the requirements provided in section 2.3 and the results that follow from Chapter 4. Subsequently, the self-assessment tool is used for assessment of the case studies with the purpose of identifying (i) the challenges faced in application of the standard and (ii) the added value that the case study results may provide to stakeholders. The considered stakeholders include people involved in the project on which the IUCN Standard is applied and people working on NbS through different ways. The three case study assessments are covered in sections 5.2 to 5.4. Lastly, section 5.5 consists of a comparison of the outcomes of the case study assessments to evaluate the most substantial challenges faced in application and the added value that the case study results may provide to stakeholders.

## 5.1 Case study selection

For the purpose of applying the IUCN Standard, three case studies have been selected based on the requirements in section 2.3 This implies that all case studies are river restoration projects with a focus on flood risk mitigation that have completed the implementation of one or more types of NbS measures. Furthermore, at least two of the case studies differ significantly for (i) each of the five most relevant features of river restoration projects, selected in section 4.3, and (ii) the types of NbS measures, categorized in section 4.4. The three case studies that have been selected are as follows:

**Case study 1 – Eddleston Water Project**

The Eddleston Water Project is a river restoration project in the Scottish Borders, established by the Scottish Government to explore the potential contribution of NFM measures (i.e., NbS with a focus on flood risk mitigation). Several types of NFM measures, such as re-meandering and log jams, have been implemented in the project. The project is managed by Tweed Forum through an empirical approach, based on detailed data collection and monitoring (Spray et al., 2022a). Most of the collected data is publicly accessible through an elaborate database of project-related documentation by Tweed Forum (2022), which makes this project unique compared to many other river restoration projects.

**Case study 2 – Project "Room for the River" Deventer**

The Project "Room for the River" Deventer, which is abbreviated to "RfR Deventer Project" for the remainder of the report, is part of the Room for the River Program in the Netherlands, which is described in section 4.4. The project is located at the city of Deventer along the river IJssel and, in contrast to the Eddleston Water project, involves the implementation of just one type of NbS measure: the excavation of floodplains to develop flood relief channels (Tweede Kamer der Staten-Generaal, 2016). Furthermore, the project has had an extensive planning and design phase from 2006 to 2012 (Waterschap Groot Salland & Waterschap Vallei en Veluwe, 2015). As the project is part of a program initiated by the Dutch Government, there are several project-related documents publicly accessible.

**Case study 3 – Missouri River Levee Setback Project**

In this research, the Missouri River Levee Setback Project is defined as two large-scale levee setbacks that were constructed on the L-575[10] of the Missouri River in Fremont County, Iowa, United States of America. Compared to the rivers at the other case studies, the Missouri River has a very large catchment and high kinetic energy, as estimated in Appendix C. The project was initiated by the U.S. Army Corps of Engineers (USACE) as part of recovery of the 2011 Missouri River flood (Krause et al., 2015). Various reports and case studies have been published on the project.

[10] "L-575" refers to the levee at the **L**eft bank of the Missouri River near river mile **575** (USACE , 2013a).

Each of the five most relevant features of river restoration projects and the category(-ies) of the types of implemented NbS measures are provided for the three case studies in Table 5.1.

*Table 5.1 – The most relevant features of river restoration projects and types of NbS measures for the three case studies.*

| Features | Case study 1 - Eddleston | Case study 2 - Deventer | Case study 3 - Missouri |
|---|---|---|---|
| **Surface area - measures** | 2.13 $km^2$<br>(Follows from calculation provided in Appendix C) | 5.4 $km^2$<br>(van de Laar et al., 2010a) | 7.04 $km^2$<br>(Krause et al., 2015) |
| **Surface area – a) subcatchment b) catchment** | **a)** Eddleston Water Catchment = 69 $km^2$<br>(Spray et al., 2022a)<br>**b)** Tweed Catchment = 5.000 $km^2$<br>(Tweed Forum, n.d.-a) | **a)** IJssel Catchment = 11.100 $km^2$ (Feld & Locker-Gruetjen, 2007)<br>**b)** Rhine Catchment = 168.000 $km^2$<br>(Dieperink, 2000) | **a)** Missouri River Catchment = 1.371.010 $km^2$<br>(Hayden, 2014)<br>**b)** Mississippi River Catchment = 3.220.000 $km^2$<br>(Chen & Gardner, 2004) |
| **Position in the catchment** | upper catchment<br>(Bracken et al., 2016) | lower catchment<br>(Klijn et al., 2018) | middle catchment<br>(Shannon, 2016) |
| **Kinetic energy of the river** | low energy<br>(Follows from calculation provided in Appendix C) | low energy<br>(Follows from calculation provided in Appendix C) | high energy<br>(Follows from calculation provided in Appendix C) |
| **Data accessibility** | elaborate publicly accessible database of project-related documentation | various project-related documents, but no complete database | project-related documentation is available, but to a limited extent |
| **Resources** | duration: 2009 - 2012 (start implementation) – current<br>costs: 2.8 million euros<br>people & resources: relatively limited<br><br>(Spray, 2017; Mott Macdonald, 2020) | duration: 2006 – 2012 (start implementation) – 2015<br>costs: 79 million euros<br>people & resources: relatively large<br><br>(Waterschap Groot Salland & Waterschap Vallei en Veluwe, 2015) | duration: 2011 - 2012 (start implementation) – 2013<br>costs: 119 million euros<br>people & resources: relatively large<br><br>(U.S. Army Corps of Engineers - Ohama District, 2013; D. Crane, personal communication, November 2, 2022) |
| **Category(-ies) of implemented NbS measures** | B - River planform adjustments<br>-> re-meandering<br>C - Planting of vegetation<br>-> woodland planting<br>D - In-channel interventions<br>-> engineered log jams<br>E - Interventions in the floodplain<br>-> pond creation<br><br>(Spray, 2017; Spray et al., 2022b) | E - Interventions in the floodplain<br>-> excavation of flood relief channels<br><br>(van de Laar et al., 2010) | A - Floodplain reconnection<br>-> levee setbacks<br><br>(Krause et al., 2015) |

## 5.2 Case study 1 – Eddleston Water Project

This section covers the application of the IUCN Standard on the first case study: the Eddleston Water Project. A description of the project and the data collection procedure are provided in sections 5.2.1 and 5.2.2, respectively. The results of the assessment and their potential added value, as indicated by a project expert, are covered in section 5.2.3. Lastly, section 5.2.4 consists of a reflection on the challenges that were faced during the assessment of the Eddleston Water Project.

### 5.2.1 Project description

The Eddleston Water is a relatively small river that is located in the Scottish Borders and has a catchment of 69 km$^2$, indicated with the red outline in Figure 5.1. The catchment drains north-south through the town of Eddleston to join the River Tweed at the town of Peebles. The Tweed catchment, which is indicated with the white outline in Figure 5.1, has a total surface area of 5000 km$^2$ of which 83 percent is located in Scotland and 17 percent in England (Spray et al., 2022b; Tweed Forum, n.d.-a).


*Figure 5.1 - Eddleston Water catchment (red outline) and Tweed catchment (white outline) (Forrester et al., 2015).*

Over the last centuries, with a peak in the later eighteenth and ninetheenth century, human interventions, such a clearance of native woodland, land drainage and afforestation with non-native conifers, signficantly altered the drainage of the Eddleston Water catchment (Harrison, 2012). Among these interventions is the straightening and embankment of a large section of the main river stem in the early 19$^{th}$ century, which was done to construct a new road, next to which a railway was constructed a few decades later. These changes to the catchment have lead to an acceleration of surface runoff, increasing the flood risk in Eddleston and Peebles, which are now both classified as "Potentially Vulnerable Areas" by SEPA (2021). In addition, human interventions have lead to the degradation of habitats for various species, among which salmonids: a species for which the River Tweed is internationally known (Spray et al., 2022b).

In response, in 2009, the Scottish Government initiated the Eddleston Water Project as an element of their programme to explore the potential contribution of NFM measures to address flood risk and habitat degradation. This program reflects a fundamental change in the perceivance of flood management in Scotland through working with natural processes, as established in the "Flood Risk Management (FRM) (Scotland) Act 2009" by the Scottish Parliament (2009).

The project has the following three main objectives:

1. To investigate the potential to reduce the risk of flooding to downstream communities through the utilisation of NFM measures.
2. To improve habitats for wildlife and raise the "ecological status" of the river, as originally defined in the EU Water Framework Directive (WFD).
3. To work with landowners and farmers in the local community to maximise the benefits of the work, whilst sustaining farming livelihoods and practices (Spray et al., 2022a).

Out of the seven major societal challenges recognized by the IUCN, as indicated in Figure 1.2b, these three project objectives address the societal challenges of (i) (flood) disaster risk reduction, (ii) ecosystem degradation and biodiversity loss, and (iii) economic and social development.

The project is managed by Tweed Forum, which is an environmental charity that works "to protect, enhance and restore the rich natural, built and cultural heritage of the River Tweed and its tributaries" (Tweed Forum, n.d.-b). Furthermore, the project is directed by a small Project Board that is chaired by the Scottish Environment Protection Agency (SEPA) and the Scottish Government, and consulted by a Steering Group of key stakeholders, such as the Scottish Natural Heritage (SNG) and Forest Research (FR). Tweed Forum fulfils the role of a trusted intermediate that collaborates closely with local farmers and stakeholders, based on trust and respect (Spray et al., 2022b). Participation of the farmers and landowners is entirely voluntarily and if they decide to allow NFM measures to be implemented on their land, they are closely involved throughout the different phases of design and implementation.

In collaboration with 21 farmers across the catchment, the following NbS measures have been implemented since the start of the implementation phase in 2012:

- 207 hectares of woodland planting (over 330.000 native trees);
- 116 engineered log jams;
- 38 flood storage ponds, of which 36 in the headwaters and 2 in the lower floodplain;
- 3.5 kilometers of re-meandering of previously straightened river and removal of adjacent flood banks, of which the effect is demonstrated in Figure 5.2 (Spray et al., 2022a).

*Figure 5.2 - – Pictures of "Lake Wood" at the Eddleston Water Project – (a) straightened river; (b) re-meandered river under normal conditions; (c) re-meandered river, storing water during a flood.*

The project was set-up as a research project in order to generate robust evidence of the impact, costs and benefits of the implementation of NFM measures at a catchment scale. Therefore, the project approach was based on detailed data collection, measurements and monitoring, such that the effectiveness of NFM could be analysed as detailed as possible. Furthermore, targets were established for specific (groups of) species (e.g., aquatic macroinvertebrates) with the aim of researching what happens in response to the implemented NFM measures (Spray et al., 2022a). A recent study by Mott Macdonald (2020) estimated that the implemented measures provide benefits from ecosystem services and avoided whole-life flood damages of 4.9 million and 1.1 million euros over a 100-year appraisal period, respectively.

### 5.2.2 Data collection

The required data for assessment of the Eddleston Water Project is collected through publicly accessible documentation, one project expert interview, supplemented with knowledge provided by a monitoring expert, and six stakeholder interviews. The literature research for publicly accessible documentation yielded the following eight sources: (Harrison, 2012), (Spray, 2017), (Werritty et al., 2010), (Spray et al., 2022a), (Spray et al., 2022b), (APEM, 2020), (Tweed Forum, 2020) and (Mott Macdonald, 2020). Furthermore, the interviewed stakeholders were selected from the three different stakeholder types given in Table 5.2. Most of the interviews with stakeholders and experts were conducted during a three-day field visit to the project location. Further details on the interviews are provided in Appendix D.

*Table 5.2 - Stakeholder types and respective names for the interviewed stakeholders at the Eddleston Water Project.*

| Stakeholder type | Stakeholder name |
|---|---|
| Farmer with measures implemented on their land | "Stakeholder 1" and "Stakeholder 2" |
| Landowners, who are not predominantly farmers, with measures implemented on their land | "Stakeholder 3" |
| Local beneficiaries without any measures implemented on their land | "Stakeholder 4", "Stakeholder 5" and "Stakeholder 6" |

### 5.2.3 Results of assessment

Carrying out the assessment procedure using the self-assessment tool (i.e., Microsoft Excel spreadsheet) of the IUCN Standard, as described in section 3.2.1, results in a percentage match of the project to each of the eight criteria of the IUCN Standard. The percentage match to each of the eight criteria, as well as the total percentage match of the Eddleston Water Project to the IUCN Standard are given in Table 5.3. A complete overview of the scores and rationale for each of the indicators can be found in Appendix E.

*Table 5.3 – Results of the assessment of the Eddleston Water Project with the IUCN Standard.*

| Criterion | Percentage match of adherence |
|---|---|
| 1. Societal challenges | 56% |
| 2. Design at scale | 67% |
| 3. Biodiversity net-gain | 67% |
| 4. Economic feasibility | 58% |
| 5. Inclusive governance | 93% |
| 6. Balance trade-offs | 44% |
| 7. Adaptive management | 56% |
| 8. Sustainability and mainstreaming | 78% |
| **Total percentage match** | **65%** |

As described in section 3.2.1, the deliverables of an assessment with the self-assessment tool of the IUCN Standard can be separated into: (1) the total percentage match and adherence to the IUCN Standard, (2) the strenghts and weaknesses of the project and (3) a radar chart. The detailed case study results and a reflection on the added value that these may provide is given below. The reflection is supported by literature research and a project expert interview, of which the details are in Appendix D.

#### 1 - Total percentage match and adherence to the IUCN Standard

Case study results

The Eddleston Water Project has a total percentage match of 65 percent to the IUCN Standard. Furthermore, the project has a percentage match of at least 25 percent to each of the individual criteria, which, as stated in section 3.2.1, implies that the Eddleston Water Project is in adherence to the IUCN Standard and can therefore be recognized (i.e., qualifies) as a NbS according to the norm of the IUCN.

Reflection – Added value of case study results

The project experts recognizes the added value of the relatively high percentage match and qualification as NbS in the confirmation that Tweed Forum is, in general, incorporating the right processes throughout the project. Furthermore, he or she mentions that the qualification as NbS may be of added value to Tweed Forum as it provides credibility to the processes of a project, which can be valuable in the application for grants and rewards, and in their efforts to bring science into policy. In the remainder of this report, the pronoun "he" is used to refer to anonymous interviewees. By using the qualification as NbS in case studies, it may also provide added value to the development of the NbS concept, since it

confirms that the project is a well-founded example of NbS, making it more likely to inspire new and ongoing (NbS) projects. An important remark is that the expert predominantly acknowledges the added value of the qualification as NbS and mentions that he would only use the total percentage match externally if it was higher than eighty percent. The only exception would be if the majority of the other well-known NbS projects would score lower than the Eddleston Water Project, however, this would imply that the IUCN Standard is closer to an aspirational standard than a realistic standard for NbS.

## 2 – Strengths and weaknesses of the project

Case study results

The scores and rationale provided for the indicators of the IUCN Standard disclose the components of the indicators (i.e., guiding questions) that the Eddleston Water Project is in line with (i.e., strenghts) and is not in line with (i.e., weaknesses). The most substantial strenghts and weaknesses of the project that follow from the assessment are described below. To begin with, the high total percentage match (*93 percent*) to Criterion 5 "Inclusive governance" indicates that the project is in line with most of the guidelines related to inclusive governance. This reveals strenghts of the Eddleston Water Project in having excellent governance arrangements, inclusive and equitable stakeholder participation and well-functioning communication. These excellent governance arrangements are proven to improve the short- and long-term sustainability of the project and enhance its Social License to Operate (IUCN, 2020a), Furthermore, the project has a high percentage match (*78 percent*) to Criterion 8 "Sustainability and mainstreaming", which reveals strenghts of the project in the elaborate attention that is paid to mainstreaming of the concept by sharing information and lessons learnt with various audiences and informing facilitating policy and regulation frameworks (e.g., the Scottish government on how the River Basin Management Planning process can work alongside the FRM Scotland Act 2009 (Spray, 2017)).

The Eddleston Water Project scores the lowest percentage match (*44 percent*) to Criterion 6 "Balance trade-offs", where trade-offs refer to situations in which a particular ecosystem service or stakeholder preferece is favored at the expense of another (IUCN, 2020b). In order to analyse what the partial match to this criterion tells about the Eddleston Water Project, a closer look is taken at the following indicators:

> **Indicator 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."*

> **Indicator 6.3:** *"Established safeguards are periodically reviewed to ensure that mutually-agreed trade-off limits are respected and do not destabilise the entire NbS."*

Indicator 6.1 is insufficiently met by the Eddleston Water Project, as trade-offs have not explicitly been documented and their potential costs and benefits have not been analysed or used to inform safeguards and corrective actions. Furthermore, indicator 6.3 is only partially met, as a number of informal trade-off limits and safeguards are in place, but these are very limited, not documented and not periodically reviewed. These are components of the indicators that the project does not align with (i.e., weaknesses), which, according to the IUCN Standard, can be improved or alleviated to have a higher chance of effectively addressing the prioritized societal challenges, while providing co-benefits. These weaknesses suggest that the Eddleston Water Project would benefit from a more elaborate assessment and documentation of trade-offs, which would involve full disclosure and agreement among affected stakeholders, and fair and transparent negotiation of compensation for damages. Furthermore, trade-off limits and safeguards should be established and documented to ensure that the integrity of ecosystems and long-term stabilizing properties of ecosystem services are not exceeded (IUCN, 2020a).

Another criterion to which the project has a relatively low percentage match (*56 percent*) is Criterion 1 "Societal challenges". This adequate match implies that the project has incorporated several processes as included in the guidelines for this criterion, but still consists of a number of weaknesses that can be or could have been improved or alleviated. A few weaknesses are identified for the following indicator:

> **Indicator 1.3:** *"Human well-being outcomes arising from the NbS are identified, benchmarked and periodically assessed."*

Even though the Eddleston Water Project contributed to human well-being through reduced flooding, enhanced recreational possibilities and a new footpath, it has a partial match to this indicator since it did not establish targets and benchmarks for human well-being, revealing these as weaknesses of the project (Mott Macdonald, 2020). This example demonstrates the implications of evaluation with a process-oriented framework, such as the IUCN Standard, which does not evaluate the results of a project.

Reflection – Added value of case study results

The project expert sees added value of the identification of strenghts of the project in the reassurance of which project components have been implemented correctly, which provides confirmation to Tweed Forum and reveals the strong elements of the project to people and/or organizations that are using it as an example. With regard to the identification of weaknesses of the project, the expert mentions the following possible scenarios of how these may and may not be of added value to Tweed Forum:

1. If identified that the project would not benefit from improving the identified weakness, it would not be of added value. This scenario is covered in more detail in section 5.2.4.
2. If identified that the project does incorporate the identified weakness, but this is not captured by the assessment, it would not be of added value.
3. If identified that the project may benefit from the identified weakness, it can be of added value through the disclosure of an opportunity to improve the project or future projects.

In addition to this third scenario, it should be stressed that certain weaknesses identified by the assessment can still be improved or alleviated within the project that is assessed, such as the documentation of upcoming trade-offs (*indicator 6.1*), while weaknesses in project phases that have already been completed, such as the establishment of targets for human well-being (*indicator 1.3*), can no longer be improved for that specific project. In that case, however, the identification of weaknesses can still provide added value by disclosing points of attention for future projects.

### 3 – Radar chart

Case study results

The radar chart of the Eddleston Water Project, which presents the percentage match to each of the eight criteria of the IUCN Standard, is provided in Figure 5.3.

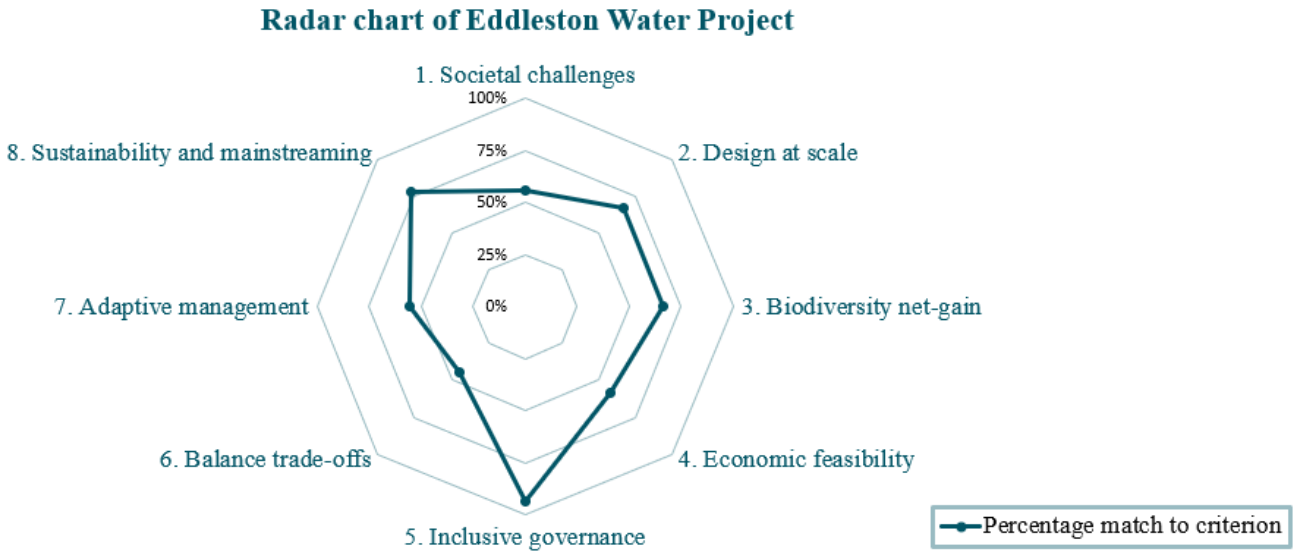


*Figure 5.3 – Radar chart of the percentage match of the Eddleston Water Project to the criteria of the IUCN Standard.*

Reflection – Added value of case study results

According to the project expert, the radar chart may provide added value by visually revealing the strong and weak elements of the project. Furthermore, he can imagine that, when the IUCN Standard is more widely used, the chart can function as a valuable tool for comparison between projects.

### 5.2.4 Reflection on assessment

This section consists of a reflection on the assessment of the Eddleston Water Project, analysing two main challenges that were faced during the assessment procedure: (i) tensions between the project objectives and the use of the IUCN Standard and (ii) multiple options for interpretation.

#### Tensions between project objectives and use of the IUCN Standard

During the assessment of the Eddleston Water Project, various indicators were provided with a low score, therefore revealing weaknesses according to the IUCN Standard, while one may argue whether the project would actually benefit from pursuing the steps to achieve a higher score and thereby "improve or alleviate the weaknesses". For projects with certain objectives, the way that particular indicators of the IUCN Standard are set up is not appropriate for the evaluation of the project. During the assessment of the Eddleston Water Project, this tension between the set-up of the IUCN Standard and the project objectives is identified for the following four types of project objectives:

1. Research project, which aims to research the effectiveness of certain measures as detailed as possible and does not seek return on investment.
2. Project with flood risk mitigation as its main objective.
3. Project with informal stakeholder engagement, based on trust.
4. Long-term project that initiates the monitoring of certain elements at later project stages.

The tensions between certain indicators and these four types of project objectives are discussed below.

<u>1 – Research project</u>

The Eddleston Water Project is a research project that aims to assess the effectiveness of certain measures as detailed as possible and does not seek return on investment. A tension between this objective and indicators 3.2 and 3.3 of the IUCN Standard is identified. In order to obtain a "strong" match to indicator 3.2, a project should have specific and measurable targets for biodiversity conservation that include the direction of desired change (*increase, decrease or maintain*), the magnitude of desired change (e.g., 80%) and the timeframe (e.g., within five years). As stated in section 5.2.1, in being a research project, the Eddleston Water Project established targets for biodiversity with the aim of researching what happens in response of the measures (i.e., no specific magnitude of desired change and timeframe). Assessment of the project with the IUCN Standard identifies the absence of specific and measurable targets for biodiversity as a weakness of the project, however, it is debatable whether a research project would benefit from specifying the exact magnitude of desired change and timeframe. Furthermore, the project has an insufficient match to indicator 3.3, which evaluates whether monitoring of the project includes periodic assessments of unintended adverse consequences on nature. As the project aims to assess the effectiveness of specific (groups of) species as detailed as possible, it can be argued whether assessment of all unintended consequences would be beneficial to the project, as this would take many resources that can otherwise be used for the monitoring of specific species.

Similar tensions were identified for indicators 4.2 and 4.3, to which the project has a "partial" match. In order to achieve higher scores for these indicators, future NbS projects would have to support the choice of NbS measures by a cost-effectiveness study and justify the affordability of the project against alternative(s). While these are important elements for many projects, a cost-effectiveness study and economic justification are not necessarily relevant for research projects that do not seek return on investment, but instead aim to choose and design measures in the most suitable manner to explore their effectiveness. Therefore, it is arguable whether future research projects would benefit from these actions.

<u>2 - Project with a focus on flood risk mitigation</u>

As indicated in Table 5.3, the Eddleston Water Project has a 56 percent match to Criterion 1 "Societal challenges", which is partly the result of a partial match to indicator 1.3 that is defined as follows:

> **Indicator 1.3:** *"Human well-being outcomes arising from the NbS are identified, benchmarked and periodically assessed."*

The partial match to this indicator is a result of a lack of targets and benchmarks for human well-being. As Criterion 1 consists of only three indicators, the partial match to indicator 1.3 has a large influence on the percentage match of the project to Criterion 1, which is defined as "NbS effectively address one or more societal challenges". The IUCN explains this large influence with the importance of addressing human well-being in differentiating between conservation actions and NbS (IUCN, 2020b). However, one may argue whether it is fair that indicator 1.3 (i.e., processes for human well-being) determines one third of the adherence to Criterion 1. This implies that projects with a different focus, such as the Eddleston Water Project that has a focus on flood risk mitigation, would obtain a relatively low score for Criterion 1 (i.e., effectively addressing societal challenges) only because they do not explicitly target and monitor human well-being. Furthermore, the Eddleston Water Project did establish clear targets and performed elaborate benchmark and periodic assessments for flood risk mitigation. These processes, which are of high importance for a river restoration project with a focus on flood risk mitigation, are not evaluated by an assessment with the IUCN Standard.

3 – Project with informal stakeholder engagement, based on trust.

The Eddleston Water Project scores the lowest percentage match to Criterion 6 "Balance trade-offs". As stated in section 5.2.3, the identified weaknesses suggest that the project would benefit from a more elaborate assessment and documentation of trade-offs, as well as the establishment and documentation of trade-off limits and safeguards. It is, however, debatable whether every project would benefit from these processes. As the Eddleston Water Project is a long-term project, the collaboration with stakeholders has a high priority. Therefore, Tweed Forum has decided to approach the engagement with farmers and landowners in a very informal manner, where communication and trade-offs are completely based on trust. In such a situation, with informal stakeholder engagement, it may be argued whether a project would benefit from having elaborate analyses and documentation on every trade-off made. This might even have negative implications on stakeholder engagement in case stakeholders are less willing to collaborate in trade-offs if these require elaborate paper-work and if formal limits and safeguards have to be established. Therefore, the "weaknesses" identified for Criterion 6 are not necessarily weaknesses of the project, demonstrating a tension with the use of the IUCN Standard.

4 – Long-term project that initiates monitoring at later project stages

The Eddleston Water Project is a long-term project that implements measures at different stages throughout its lifetime. This is the result of (extensive) negotiations with landowners until measures can be implemented, as well as a three-year funding program, which implies that the implementation of measures is sometimes delayed until new funding is acquired. As result, monitoring is initiated at different project stages. This results in a tension with indicator 3.2, which is defined as follows:

> **Indicator 3.2:** *"Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed."*

The corresponding guiding questions, as provided in Appendix B, evaluate whether (i) clear and well-founded targets have been established, (ii) a suitable monitoring system is in place to monitor the targets and (iii) benchmark and periodic assessments have been conducted for the set targets. As these guiding questions refer to the monitoring and assessments for the set targets, monitoring and assessments at later stages of the project are excluded from the assessment. As a result, monitoring that has been initiated at a later stage of the Eddleston Water Project and does not reflect on pre-set targets, such as the research by Gyger (2022) on the ecological benefits of flood storage ponds, is not evaluated in the assessment.

### Multiple options for interpretation

The other challenge that was faced during the assessment procedure is that certain indicators and accompanied guiding questions can be interpreted in multiple ways with regard to their application to the Eddleston Water Project. Regarding this matter, two types of situations are identified. To begin with, indicator 4.1 and the accompanied guiding questions do not include sufficient details and therefore allow for multiple interpretations. This can be clarified using its definition on the following page.

**Indicator 4.1:** *"The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented."*

The indicator, as well as the accompanied guiding questions, do not specify whether the identification and documentation of costs and benefits must be performed prior to implementation or whether this can also be done at later project stages. As for the Eddleston Water Project an elaborate analysis of costs and benefits has been performed at a later stage of the project, the most straightforward score is a "strong" match. However, the other indicators of Criterion 4 specifically refer to economic studies prior to implementation. In the context of these other indicators, a user of the self-assessment tool may therefore interpret the indicator differently and provide a "insufficient" match.

During assessment of the Eddleston Water Project, five indicators, provided with a double red outline in Appendix E, were identified for which the indicators and accompanied guiding questions can either be interpreted in a strict manner, following the guidance in detail, or with sound judgement, taking into account the project context. This can be clarified using indicator 1.1, which is defined as follows:

**Indicator 1.1:** *"The most pressing societal challenges for rights holders and beneficiaries are prioritized".*

The societal challenges that were prioritized by the Eddleston Water Project through its main objectives are in line with the challenges that rights holders and beneficiaries mentioned to be most pressing during the interviews. As only one beneficiary mentioned a challenge that was not prioritized, based on sound judgement, a suitable score to indicator 1.1 would be an "adequate" match. However, the accompanied guiding questions and scoring guidance in Appendix B stress that the prioritization of societal challenges should be based on consultation with rights holders and beneficiaries in advance. As stakeholders were not consulted on their most pressing societal challenges prior to development of the project objectives, evaluation based on strict interpretation provides an "insufficient" match to the indicator.

The influence of interpreting all five indicators in a strict manner or with sound judgement on the case study results is demonstrated by means of the radar chart in Figure 5.4. This chart indicates that the differences in percentage matches to the criteria are relatively small and the trend of the charts is similar. This reveals that, for the assessment of the Eddleston Water Project, the IUCN Standard is sufficiently robust to overcome that these differences in interpretation lead to significantly different results.

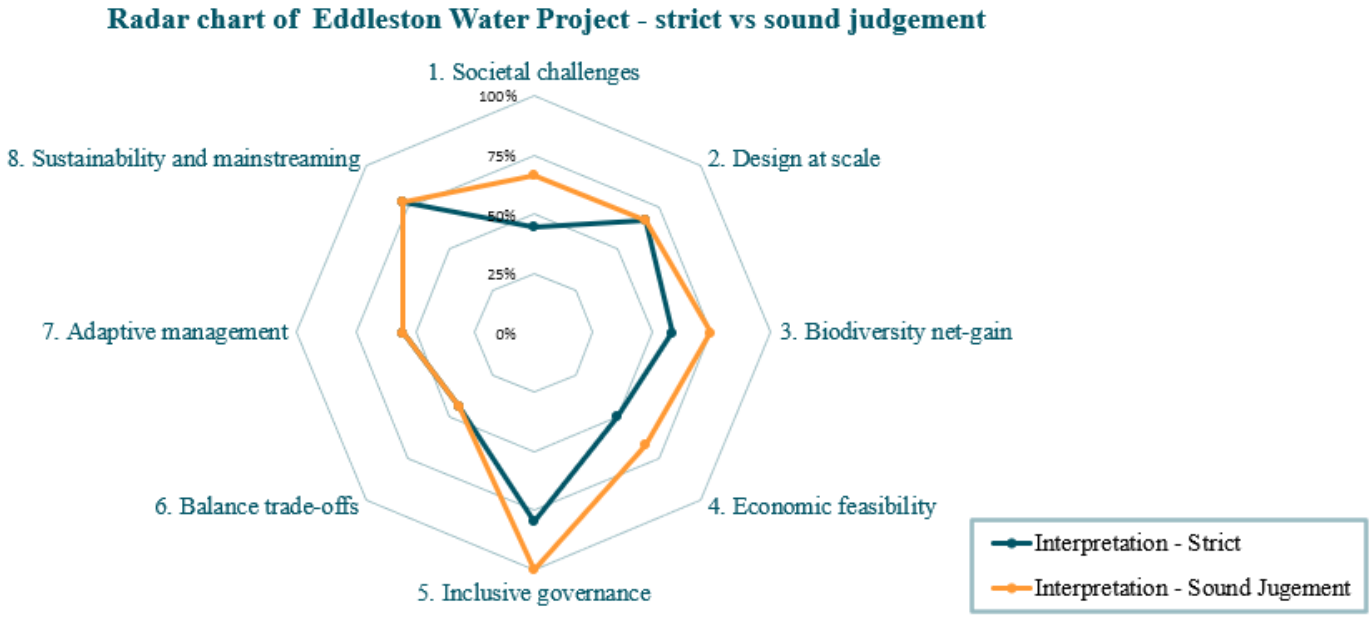


*Figure 5.4 – Radar chart of the percentage match of the Eddleston Water Project to the criteria of the IUCN Standard, for (i) a strict interpretation and (ii) an interpretation based on sound judgement.*

## 5.3 Case study 2 – Project "Room for the River" Deventer

This section covers the application of the IUCN Standard to the second case study: Project "Room for the River" Deventer. A project description and details on the data collection procedure are provided in sections 5.3.1 and 5.3.2, respectively. The results of the assessment and their potential added value, as indicated by a project expert, are covered in section 5.3.3. Lastly, section 5.3.4 consists of the challenges that were faced during assessment of the RfR Deventer Project.

### 5.3.1 Project description

In 1993 and 1995, the water levels in the Dutch rivers were extremely high and there were serious worries that the levees would break at several locations. Based on the current trends of climate change, similar scenarios of extremely high water levels due to large amounts of precipitation and/or meltwater were expected in the future. In response, the Dutch government initiated the Room for the River Program, implementing measures at 30 locations in the Netherlands with the following two objectives:

1. By 2015, the flood safety of the Dutch rivers must meet the legally established standard in 2001, which for the Rhine branches is a normative discharge of 16.000 $m^3/s$ at Lobith.
2. The spatial quality of the riverine areas in the Netherlands must be improved.
   (Tweede Kamer der Staten-Generaal, 2005)

Two of these locations are situated at the city of Deventer, along the river IJssel, which is a tributary of the Rhine that flows northward and discharges into the IJsselmeer. The locations, named the "Bolwerksplas, Worp and Ossenwaard" (BWO) and the "Keizers- and Stobbenwaarden and Olsterwaarden" (KSO), together form the RfR Deventer Project (Gemeente Deventer & Provincie Overijssel, 2007). Both project areas are indicated in Figure 5.5.

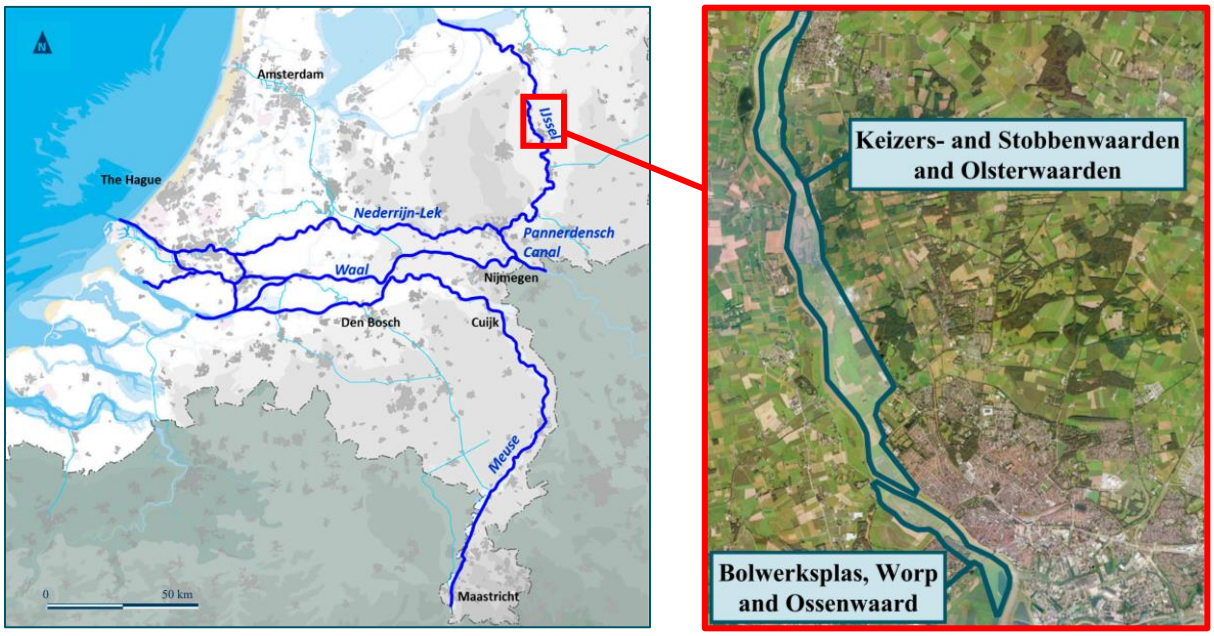


*Figure 5.5 – (a) IJssel river (Klijn et al., 2018); (b) Project areas of the RfR Deventer Project (DN Urbland, 2007).*

At both locations, the floodplain was excavated to create flood relief channels that will increase the discharge capacity during high water levels, illustrated in Figure 5.6. Specific to the project, the objectives were translated into (1) a reduction of the normative high-water level of 17 and 10 centimeters at the BWO and KSO, respectively, and (2) targets for the spatial quality, composed of the landscape, nature, cultural heritage, recreation, liveability and shaping of the channels, in the Spatial Quality Framework (DN Urbland, 2007). Out of the seven major societal challenges recognized by the IUCN, as indicated in Figure 1.2b, these objectives address the societal challenges of (i) (flood) disaster risk reduction, (ii) ecosystem degradation and biodiversity loss, and (iii) human health.

The municipality of Deventer and the province of Overijssel were responsible for the planning phase of the project areas BWO and KSO, respectively. They were supported by a steering group, composed of the affected provinces, municipalities and water boards, the managing board of the Room for the River program, Rijkswaterstaat – East Netherlands and foundation IJssellandschap. In addition, there was a sounding board, which included residents of the project area that represent different interest groups, and a local and national quality team to periodically evaluate the spatial quality within the plans (Van de Laar et al., 2010b). The water boards Groot Salland, which is now called Drents Overijsselse Delta, and Vallei and Veluwe were responsible for the implementation of the project (Waterschap Groot Salland & Waterschap Vallei en Veluwe, 2015). After implementation of the project in 2015, the different project groups were disbanded, and maintenance and monitoring of the project area was transferred to the landowners.

*Figure 5.6 – Flood relief channels next to the river Ijssel at the Zandweerd Pond (van Gerner, 2015)*

In addition to the flood relief channels, various other interventions contributing to flood risk mitigation and/or spatial quality have been implemented. One of them is the "Natuurderij", which is a so-called "ecological water farm" that combines biodynamic agriculture, nature, recreation and floodplain maintenance by cattle grazing (Havinga & der Nederlanden, 2018). The flood relief channels and complementary interventions, together, resulted in (1) a reduction of the normative high-water level of 18 and 8 centimeters at BWO and KSO, respectively, and (2) a strong improvement of the spatial quality (Waterschap Groot Salland & Waterschap Vallei en Veluwe, 2015; Wolbers et al., 2018).

### 5.3.2 Data collection

The required data for assessment of the RfR Deventer Project is collected through publicly accessible documentation, three project expert interviews, supplemented with knowledge provided by two monitoring experts, and one interview with a key stakeholder. The literature research for publicly accessible documentation yielded the following eight sources: (Gemeente Deventer & Provincie Overijssel, 2007), (Ruimtelijke plannen - Deventer, 2011), (Platteeuw et al., 2004), (Van De Laar et al., 2010a), (Van de Laar et al., 2010b), (Hartgers et al., 2015), (DN Urbland, 2007) and (Ebregt et al., 2005). During a half-day field visit to the project location, one interview was conducted and further knowledge of the project was acquired. More details on the interviews are provided in Appendix D.

### 5.3.3 Results of assessment

Carrying out the assessment procedure using the self-assessment tool (i.e., Microsoft Excel spreadsheet) of the IUCN Standard, as described in section 3.2.1, results in a percentage match of the project to each of the eight criteria of the IUCN Standard. The percentage match to each of the eight criteria, as well as the total percentage match of the Eddleston Water Project to the IUCN Standard are given in Table 5.4. A complete overview of the scores and rationale for each of the indicators can be found in Appendix F. The deliverables, separated into (1) the total percentage match and adherence to the IUCN Standard, (2) the strenghts and weaknesses of the project and (3) a radar chart, are given in detail, together with a reflection on the added value that these may provide, below Table 5.4. The reflection is supported by literature research and an interview with a project expert, of which the details are in Appendix D.

*Table 5.4 – Results of the assessment of the RfR Deventer Project with the IUCN Standard.*

| Criterion | Percentage match of adherence |
|---|---|
| 1. Societal challenges | 78% |
| 2. Design at scale | 89% |
| 3. Biodiversity net-gain | 50% |
| 4. Economic feasibility | 67% |
| 5. Inclusive governance | 73% |
| 6. Balance trade-offs | 67% |
| 7. Adaptive management | 44% |
| 8. Sustainability and mainstreaming | 33% |
| **Total percentage match** | **63%** |

### 1 – Total percentage match and adherence to the IUCN Standard

Case study results

The RfR Deventer Project has a total percentage match of 63 percent to the IUCN Standard and a percentage match of at least 25 percent to each of the individual criteria. Therefore, as stated in section 3.2.1, the RfR Deventer Project qualifies as a NbS according to the norm of the IUCN.

Reflection – Added value of case study results

According to the project expert, the qualification as a NbS and total percentage match, under the condition that it is high relative to other projects, provide credibility to the RfR Deventer Project as a well-founded example of NbS. This credibility may be of added value to people and/or organizations that are planning to have initiate(d) a NbS project by ensuring them that the RfR Deventer Project is a suitable example for inspiration and guidance. By inspiring and guiding new NbS projects, the deliverables contribute to the development of the NbS concept as well. Furthermore, the project expert recognizes added value for the contractor of the project, who may use the total percentage match and/or qualification as NbS as addition substantiation in the references of their next tenders.

### 2 – Strenghts and weaknesses of the project

Case study results

The RfR Deventer Project scores the highest percentage match (*89 percent*) for Criterion 2 “Design at scale”, which indicates that the design of the project takes into account the complexity and uncertainty that occur within and beyond the project area. More specific, the assessment reveals strengths of the project (i.e., components of the indicators that the project is in line with) in the integration of complementary interventions and interactions between sectors in design (i.e., complexity) and in its elaborate risk identification and management (i.e., uncertainty). The integration of complexity and uncertainty in the project design most likely increases the durability and sustainability of the project (IUCN, 2020a). Furthermore, the project has a high percentage match (*78 percent*) to Criterion 1 “Societal Challenges”. The most significant strenghts of the project, revealed in the assessment of this criterion, are the prioritization of the most pressing societal challenges, the identification and documentation of the drivers of these challenges and the development of targets for human well-being.

The seventy-eight percent match of the RfR Deventer Project to Criterion 1 also indicates that the project is not completely in line with all of the components of the indicators for this criterion. Two components of the guidelines for this criterion that the project does not comply to (i.e., weaknesses) are the consultation of rightsholders and beneficiaries on their most pressing challenges and the development of specific and measurable targets for human well-being. Furthermore, the RfR Deventer Project has a partial match of 44 percent to Criterion 7 “Adaptive Management”, which reveals significant weaknesses of the project in the absence of (i) a clear project strategy that precisely states the intended

outcomes, actions and assumptions, and (ii) an interconnected monitoring plan that includes adaptive management responses. As ecosystems are complex, dynamic and self-organising systems, (NbS) projects should be based on a theory of change that is adapted based upon evidence (IUCN, 2020b). Where the RfR Deventer Project has integrated adaptive management responses in its risk management plan, it is of importance that adaptive management is also planned and implemented based on the implementation and monitoring plan, as this allows to capture short-term impacts on nature and people.

The absence of a monitoring plan is also reflected by the "partial" and "insufficient" match of the project to indicators 3.2 and 3.3, respectively, which reveals that the effects on biodiversity as result of the project have not been benchmarked or periodically assessed and that unintended adverse consequences of the project on nature have not been monitored. The development and implementation of a monitoring plan would have helped to manage positive and negative long-term impacts and to evaluate whether the project has effectively addressed its prioritized societal challenges and provided co-benefits. In addition, organized monitoring allows to (i) evaluate and report the contributions of the project to national and global targets, and (ii) inform and enhance policy and regulation frameworks. These are two important steps for the mainstreaming and upscaling of NbS, which were not done for the RfR Deventer Project, as reflected by the low percentage match (*33 percent*) to Criterion 8 "Sustainability and Mainstreaming".

Reflection – Added value of case study results

As the RfR Deventer Project has already been completed and the project groups have been disbanded, the identified strenghts and weaknesses cannot provide added value in terms of improving or upscaling the project. However, as mentioned by the project expert, the identified strenghts may provide added value to other people and/or organizations that are using the RfR Deventer Project as an example by revealing the project components that have correctly been implemented. Furthermore, the project expert stresses that clients and project organizations often go from one project to the other, quickly shifting their focus and not conducting an in-depth assessment of their previous projects. As result, a lot of learning opportunities are missed. The project expert believes that the same applies to the RfR Deventer Project, where one of the major lessons learnt should be that a monitoring-element is attached to future programs. He recognizes that these learning opportunities can effectively be revealed to clients and project organizations through the identification of weaknesses with the IUCN Standard.

### 3 – Radar chart

Case study results

The radar chart of the RfR Deventer Project, which presents the percentage match to each of the eight criteria of the IUCN Standard, is provided in Figure 5.7.

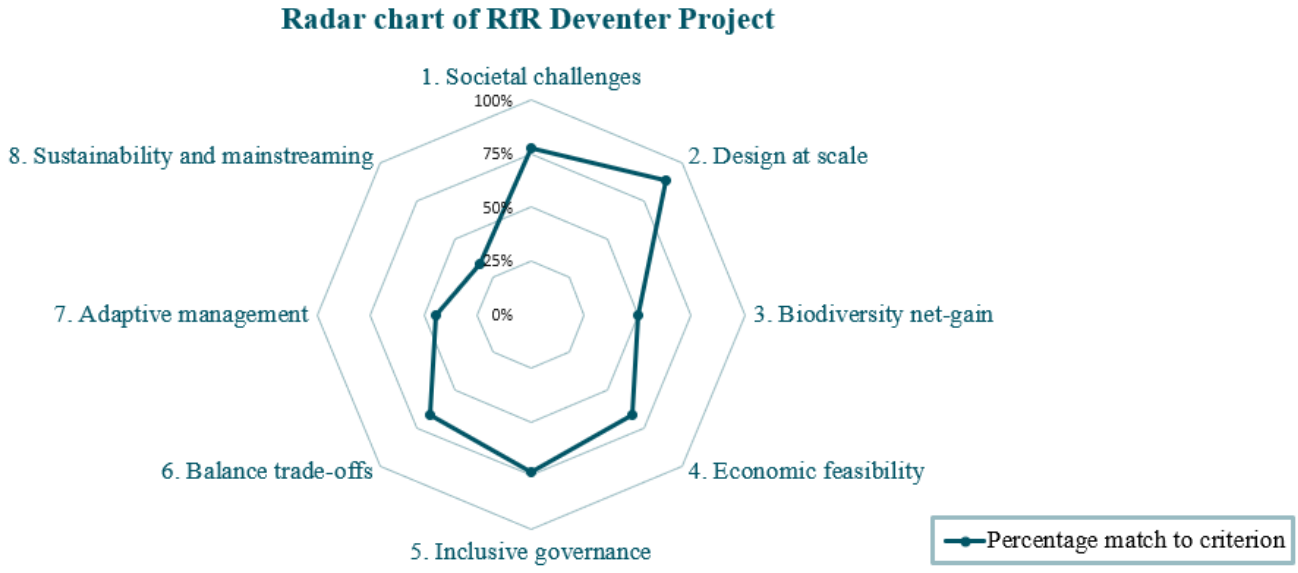


*Figure 5.7 – Radar chart of the percentage match of the RfR Deventer Project to the criteria of the IUCN Standard.*

Reflection – Added value of case study results

Similar as for the Eddleston Water Project, the project expert sees added value in the radar chart as a tool for the comparison of projects. More specifically, he mentions that the shape of radar chart can be used to identify projects that score higher on criteria to which the assessed project scores relatively low. These projects can then be analysed to identify which implemented processes lead to these higher scores, providing learning opportunities to the project organisation.

### 5.3.4 Reflection on assessment

This section consists of a reflection on the assesment of the RfR Deventer Project, analysing three types of challenges that were faced during data collection and the assessment procedure: (i) tensions between the project objectives and the use of the IUCN Standard, (ii) multiple options for interpretation and (iii) limited data accessibility.

#### Tensions between project objectives and use of the IUCN Standard

Similar to the assessment of the Eddleston Water Project, tensions are identified between the set-up of the IUCN Standard and objectives of the RfR Deventer Project. These tensions are reflected by low scores for indicators for which it is arguable whether the project and other projects with similar objectives would benefit from pursuing the steps to achieve higher scores and thereby improve or alleviate the identified "weaknesses". The types of objectives of the RfR Deventer Project for which a tension with the use of the IUCN Standard is identified are as follows:

1. Project that is part of and contributes to the objectives of a (national) program.
2. Project that aims to achieve maximum effect within a fixed budget.
3. Project with flood risk mitigation as its main objective.

The tension between the use of the IUCN Standard and projects with a focus on flood risk mitigation is also identified for the Eddleston Water Project and covered in section 5.2.4, whereas the tensions with the other two project objectives are discussed below.

1 – Part of a (national) program

The RfR Deventer Project is part of the national Room for the River program, which has two main objectives that apply to all of its projects. This results in a tension with the assessment of indicator 1.1, which reveals the fact that rights holders and beneficiaries were not consulted on their most pressing societal challenges as a weakness of the project. However, as the objectives were already determined on (national) programmatic level, the project would not have derived benefits from consulting rights holders and beneficiaries on their most pressing challenges to improve at the identified 'weakness'.

2 – Fixed budget

Another objective of the RfR Deventer project, which is often the case for projects that are part of (national) programs, is that the project aims to achieve the maximum effect within a fixed budget. This results in tensions with indicators 4.2 and 4.4, which reveal the absence of a cost-effectiveness study and a portfolio of resourcing options as weaknesses of the project. However, as the project receives a fixed budget, the value in conducting a cost-effectiveness study is limited and it is not necessary to consider different resourcing options. Therefore, it is debatable whether the project would benefit from pursuing the steps to improve at these "weaknesses".

#### Multiple options for interpretation

During assessment of the RfR Deventer Project, there were multiple options for the interpretation of a number of indicators. The indicators for this which occurred due to (i) an insufficient amount of details in the guidance or (ii) the possibility to interpret the indicator and guidance in a strict manner or with sound judgement, are provided with a (i) single or (ii) double red outline in Appendix F. The influence of interpreting the relevant indicators in a strict manner or with sound judgement on the case study results is demonstrated by means of the radar chart in Figure 5.8. The chart indicates that, for the RfR

Deventer Project, repetitive interpretation in either a strict manner or with sound judgement results in a large difference in the percentage match to the first and seventh criterion. Strict interpretation of the seventh criterion results in an insufficient match, implying that the project would not qualify as a NbS.

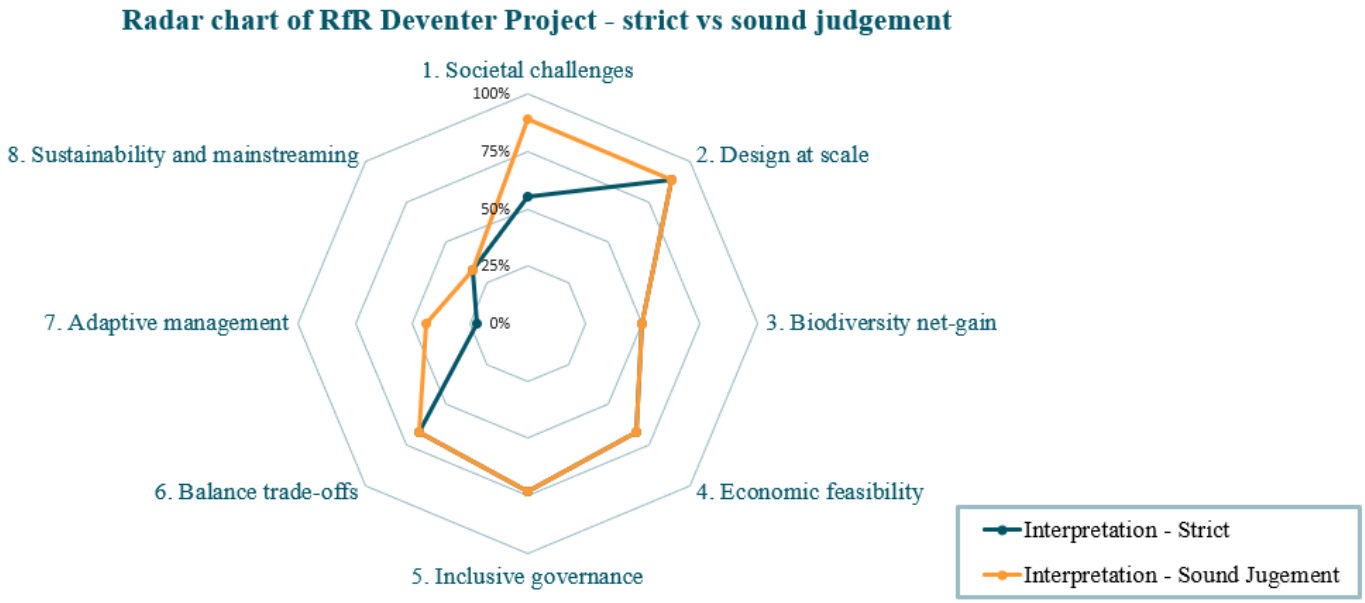


*Figure 5.8 – Radar chart of the percentage match of the RfR Deventer Project to the criteria of the IUCN Standard, for (i) a strict interpretation and (ii) an interpretation based on sound judgement.*

### Limited data accessibility

The limited accessibility of relevant project-related documentation and difficulties in identifying the relevant documents are two challenges faced in the assessment of the RfR Deventer Project. Several project-related documents that are relevant for the assesment, such as the communication strategy and cost-benefit analysis, are not publicly accessible. Furthermore, the relevant data that was publicly accessible was collected through various different websites and documents, where identification of the Spatial Quality Framework by DN Urbland (2007) required additional search terms provided by a project expert. The required data that was not collected through publicly accessible documentation was collected through project expert interviews and therefore the limited data accessibility was not a substantial barrier to the application of the IUCN Standard to the project. However, the limited amount of publicly accessible documentation and the challenges in collection of the relevant documents did result in additional time and effort that was spent on the assessment.

## 5.4 Case study 3 – Missouri River Levee Setback Project

This section covers the application of the IUCN Standard to the third case study: the Missouri River Levee Setback Project. A description of the project and the data collection procedure are provided in sections 5.4.1 and 5.4.2, respectively. Furthermore, section 5.4.3 consists of the results and their potential added value, as indicated by a project expert, and section 5.4.4 consists of a reflection on the challenges that were faced during the assessment of the project.

### 5.4.1 Project description

In 2011, extremely heavy spring rains combined with relatively large amounts of meltwater runoff within the Missouri River Basin, indicated in Figure 5.9a, caused flooding along the main river and many of its tributaries. The Missouri River Levee Unit L-575 sustained substantial damage at 21 sites, including levee seepage and piping, erosion of the riverside and breaches at three locations. As part of the Public Law (PL) 84-99 Emergency Levee Rehabilitation Program, the USACE provided emergency assistance to the levee sponsor, who operates and maintains the levee, in the form of post-flood levee repair (USACE , 2013a). During the in-line repairs on L-575, it was determined that the damage to two

large sections of the levee was significant to the degree that permanent in-line repair of the levee would be more expensive than constructing a levee setback (USACE, 2013b). Therefore, as a least-cost alternative, two large-scale levee setbacks were constructed, reconnecting the Missouri River to approximately 7 km$^2$ of its floodplains, as indicated in Figure 5.9b (Krause et al., 2015).

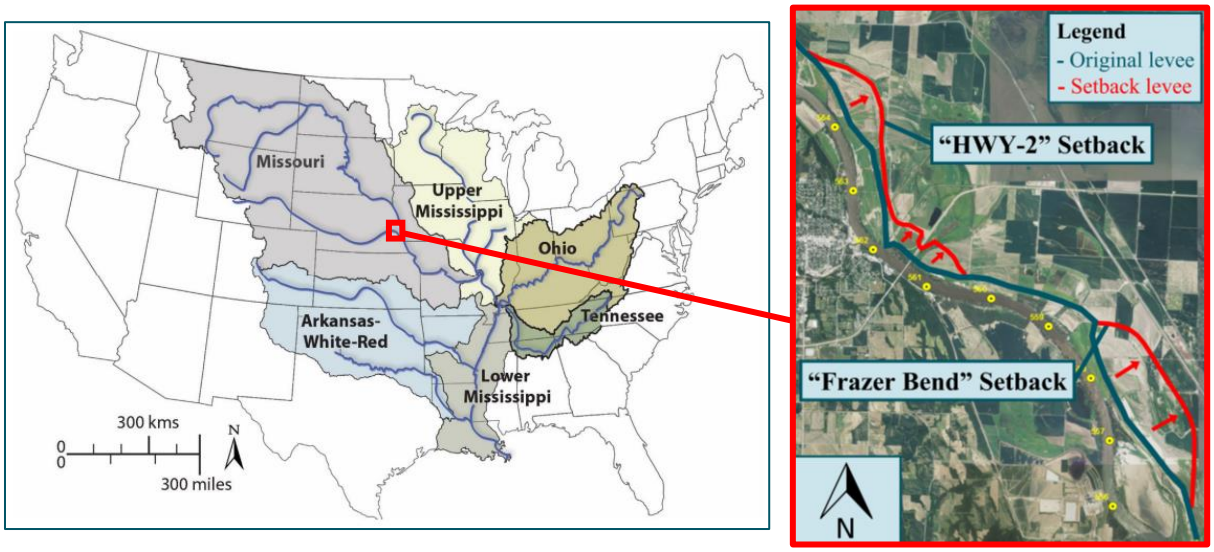


*Figure 5.9 – (a) Missouri River Basin as part of the Mississippi River Basin (Kannan et al., 2019); (b) Missouri River Levee Unit L-575 setbacks with original levee (blue) and setbacks (red) (USACE , 2013a).*

As part of the PL 84-99 Program, the only objective of the levee setbacks at Levee Unit L-575 was to rehabilitate the levee for flood risk reduction. Even though levee setbacks are known to provide environmental benefits, habitat creation was not a purpose of the project (USACE, 2013b). This implies that, out of the seven major societal challenges recognized by the IUCN, as indicated in Figure 1.2b, the project solely addresses (flood) disaster risk reduction.

In accordance with Engineering Regulation (ER) 500-1-1 by the USACE (2001), the levee setbacks were completely funded by the USACE as a least cost alternative. Typically, under the PL 84-99 Program, the levee sponsor would supply the real estate and borrow material for the new levee alignment. However, for the levee setbacks at L-575, the land was owned by the USACE as part of the Missouri River Rehabilitation Program (MRRP) for habitat restoration purposes. As the borrow material was retrieved from this land, the need for the levee sponsor to supply the real estate and borrow material was alleviated (Krause et al., 2015). For the construction of the levee setbacks, illustrated in Figure 5.10, the USACE coordinated with several organizations to mitigate the adverse environmental consequences as much as possible. One of the interventions was treatment of 1.3 km$^2$ of borrow pits for wetland establishment by creating mild slopes, irregular shapes and planting seeds (USACE , 2013a).

*Figure 5.10 – Misouri River Levee Unit L-575 'HWY-2' Setback under construction in October, 2012 (Crane, 2012).*

The reconnection of the river with its floodplain and the habitat creation at the borrow pits enhance the ecosystem connectivity, topographical diversity of the floodplain and groundwater upwelling connectivity. Since the implementation, increased growth of native flora and fauna, as well as various migratory birds have been observed at the levee setback areas (D. Crane, personal communication, October 20, 2022). As result of its ecological added value, the project has been recognized through terminologies for similar concepts to NbS, such as EwN (Bridges et al., 2018) and NNBF (Bridges et al., 2021a).

### 5.4.2 Data collection

The required data for assessment of the Missouri River Levee Setback Project is collected through publicly accessible documentation and two project expert interviews. The literature research for publicly accessible documentation yielded the following six sources: (Krause et al., 2015), (USACE , 2013a), (Smith et al., 2017), (Farmer, 2013), (USACE, 2013b) and (USACE, 2018). Further details on the expert interviews can be found in Appendix D. Furthermore, for this case study, no stakeholder interviews were conducted and there was no field visit to the project location.

### 5.4.3 Results of assessment

Carrying out the assessment procedure using the self-assessment tool (i.e., Microsoft Excel spreadsheet) of the IUCN Standard, as described in section 3.2.1, results in a percentage match of the project to each of the eight criteria of the IUCN Standard. The percentage match to each of the eight criteria, as well as the total percentage match of the Missouri River Levee Setback Project to the IUCN Standard are given in Table 5.5. A complete overview of the scores and rationale for the indicators is given in Appendix G.

*Table 5.5 – Results of the assessment of the Missouri River Levee Setback Project with the IUCN Standard.*

| Criterion | Percentage match of adherence |
|---|---|
| 1. Societal challenges | 67% |
| 2. Design at scale | 56% |
| 3. Biodiversity net-gain | 33% |
| 4. Economic feasibility | 42% |
| 5. Inclusive governance | 40% |
| 6. Balance trade-offs | 22% |
| 7. Adaptive management | 22% |
| 8. Sustainability and mainstreaming | 22% |
| **Total percentage match** | **38%** |

As described in section 3.2.1, the deliverables of an assessment with the self-assessment tool of the IUCN Standard can be separated into: (1) the total percentage match and adherence to the IUCN Standard, (2) the strenghts and weaknesses of the project and (3) a radar chart. The detailed case study results and a reflection on the added value that these may provide is given below. The reflection is supported by literature research and a project expert interview, of which the details are in Appendix D.

#### 1 – Total percentage match and adherence to the IUCN Standard

Case study results

The Missouri River Levee Setback Project has a total percentage match of 38 percent to the IUCN Standard. Furthermore, the project has a percentage match below 25 percent for the last three criteria. For this reason, as stated in section 3.2.1, the Missouri River Levee Setback Project is not in adherence to the IUCN Standard and does not qualify as a NbS according to the norm of the IUCN.

Reflection – Added value of case study results

The project expert is not content with the deliverable that the project does not qualify as a NbS. As the IUCN Standard is process-oriented, as covered in section 3.3.1, it can be used to evaluate the processes of a project. Therefore, the expert is not surprised that the levee setbacks at L-575, which are part of the PL 84-99 Program and therefore have a very limited planning process, are not in adherence to the IUCN Standard. However, the expert believes that the setbacks are still a strong example of NbS due to their ecological added value, which is not captured by the IUCN Standard as it does not evaluate the project results. The identification of the project as a NbS by the expert is in line with the recognition it receives

as EwN and NNBF, as stated in section 5.4.1. For this reason, the expert would prefer that instead of claiming that the project is not a NbS, it is framed as not being in adherence to the IUCN Standard.

When framed as a low percentage match to the IUCN Standard, the expert believes that the deliverable can provide added value to the USACE by raising awareness that, even though the PL 84-99 Program aims to be executed as fast as possible, there is room for improvement in the current planning processes. Maximising the rapid planning process of the PL 84-99 Program may increase the effectiveness of projects in addressing various societal challenges. Awareness of this matter among the USACE may lead to future efforts of strengthening the robustness of projects under 84-99 by paying additional attention to the weaknesses identified in this assessment and/or using the IUCN Standard as guidance.

### 2 – Strengths and weaknesses of the project

Case study results

The Missouri River Levee Setback Project scores the highest percentage match (*67 percent*) to Criterion 1 "Societal Challenges". This adequate match reveals strenghts of the project (i.e., components of the indicators that the project is in line with) in the prioritization of the most urgent societal challenges and thorough understanding of these challenges. The project does, however, fall short at setting targets and periodically evaluating human well-being. The only other criterion for which the project scores an "adequate" match (*56 percent*) is Criterion 2 "Design at scale", which indicates the extent to which the design accounts for complexity and uncertainty. Design of the project takes into account complexity by integrating complementary interventions, such as habitat creation with borrow bits, but insufficiently accounts for uncertainties, as risk identification and management are both limited to hydraulic risks. Furthermore, the project has an insufficient match (*22 percent*) to Criterion 6 "Balance trade-offs", Criterion 7 "Adaptive Management" and Criterion 8 "Sustainability and mainstreaming", revealing the weaknesses (i.e., components of the indicators that the project is not in line with) indicated in Table 5.6.

*Table 5.6 – Weaknesses that follow from the assessment of the Missouri River Levee Setback Project with the IUCN Standard.*

| Indicator(s) | Weakness of the Missouri River Levee Setback Project |
|---|---|
| Indicator 6.1 | No identification of costs and benefits of trade-offs. |
| Indicator 6.1 & 6.3 | No establishment of trade-off limits and safeguards. |
| Indicator 7.1 | Limited project strategy, without (changes in) assumptions. |
| Indicator 7.1, 7.2 & 7.3 | No monitoring and evaluation plan. |
| Indicator 7.3 | No framework for iterative learning and adaptive management. |
| Indicator 8.1 | No communication (strategy) to trigger transformative change. |
| Indicator 8.2 | No informing or enhancing of policy and regulation frameworks. |
| Indicator 8.3 | No identification of the contribution to national or global targets. |

Reflection – Added value of case study results

The project expert believes that, in the process of strengthening the robustness of future projects under PL 84-99, the identified strenghts and weaknesses can provide added value to the USACE by disclosing the strong elements and the points of attention. The weaknesses in particular may be valuable in maximizing the effectiveness within the restricted planning process of the PL 84-99 Program. In addition, he recognizes the added value of the identified weaknesses to other organizations working on (NbS) projects by revealing the elements on which additional attention should be spent.

An important remark by the project expert is that many of the weaknesses would not have been identified for (i) the relatively recent levee setback at L-536 (under PL 84-99) and (ii) levee setbacks under the traditional civil works planning process of the USACE. For the levee setbacks at L-536 there were various landowners that had to collaborate, resulting in a more extensive planning processes, as captured by The Nature Conservancy (2021). Furthermore, the tradition planning process of the USACE is far more detailed and, for instance, incorporates the assessment of trade-offs. The expert mentions that

application of the IUCN Standard to these two scenarios would provide significantly different results, while he recognizes that also in these scenarios the identified weaknesses may provide added value by revealing the points of attention for future projects. Lastly, the project expert expresses interest in comparing the current PL 84-99 and traditional civil works planning processes to the guidelines in the IUCN Standard in order to identify possibilities to optimize the planning processes of the USACE.

### 3 – Radar chart

Case study results

The radar chart of the Missouri River Levee Setback Project, which presents the percentage match to each of the eight criteria of the IUCN Standard, is provided in Figure 5.11.

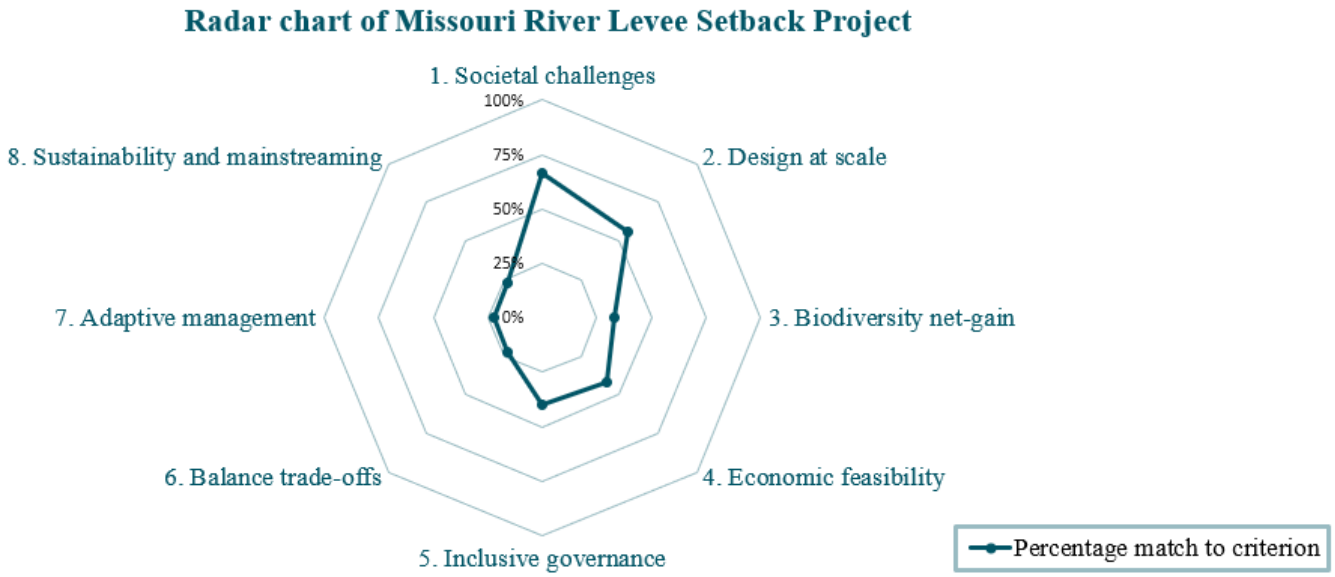


*Figure 5.11 – Radar chart of the percentage match of the Missouri River Levee Setback Project to the criteria of the IUCN Standard.*

Reflection – Added value of case study results

The project expert mentions that the radar chart is an excellent visual representation of the case study results, from which the other types of deliverables can also be derived. Furthermore, he recognises the added value that the chart can provide in the identification of the project characteristics that drive the strenghts and weaknesses of the project. Also, he sees added value in the chart as a tool for comparison, although this would require wide application of the IUCN Standard. According to the expert, it would be valuable to create a well-functioning user-base for the IUCN Standard, which would allow users to compare the assessment of different (NbS) projects, providing learning opportunities.

### 5.4.4 Reflection on assessment

This section consists of a reflection on the assessment of the Missouri River Levee Setback Project, analysing four types of challenges that were faced during data collection and assessment: (i) tensions between the project objectives and the use of the IUCN Standard, (ii) multiple options for interpretation, (iii) collection of contradictory data and (iv) absence of stakeholder interviews. Also, challenges were faced due to a limited data accessibility, which are similar to those described in section 5.3.4.

#### Tensions between project objectives and use of the IUCN Standard

Similar to the other two case studies, tensions are identified between the set-up of the IUCN Standard and the objectives of the Missouri River Levee Setback Project. These tensions are reflected by low scores for indicators for which it is arguable whether the project and projects with similar objectives would benefit from pursuing the steps to achieve higher scores and thereby improve or alleviate the

identified “weaknesses”. The types of project objectives of the Missouri River Levee Setback Project for which a tension with the use of the IUCN Standard is identified are as follows:

1. Emergency rehabilitation project, which aims to be executed as soon as possible.
2. Project with flood risk mitigation as its main objective.
3. Project that is part of and contributes to the objectives of a (national) program.
4. Project that aims to achieve maximum effect within a fixed budget.

The last three project objectives are also applicable to the other case studies and therefore covered in more depth in sections 5.2.4 and 5.3.4. The tension between the objectives of an emergency rehabilitation project and the use of the IUCN Standard is discussed below.

1 – Emergency rehabilitation project

As part of the PL 84-99 Emergency Levee Rehabilitation Program, the Missouri River Levee Setback Project aims to be executed as fast as possible, which results in a tension with a number of indicators. This can be demonstrated with indicator 5.1, which is defined as follows:

> **Indicator 5.1:** *“A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention can be initiated.”*

Since no formal feedback and grievance resolution mechanism was established prior to construction of the levee setbacks at L-575, the project has an “insufficient” match to this indicator, therefore revealing weaknesses of the project according to the IUCN Standard. One may, however, argue whether it is worth spending time on the development of a feedback and grievance mechanism, based on consultation with stakeholders, while human lives, houses and nationally significant transportation corridors are at risk. The same applies to a number of the other weaknesses that are identified, for which it is debatable whether the benefits provided by pursuing the steps to achieve a higher score outweigh the time and effort lost that could otherwise have been used for a faster construction of the levees.

### Multiple options for interpretation

During assessment of the Missouri River Levee Setback Project, a number of indicators can be interpreted in multiple ways due to (i) an insufficient amount of details in the guidance, or (ii) the possibility to interpret the indicator and guidance in a strict manner of with sound judgement, which are provided with a (i) single or (ii) double red outline in Appendix G. The influence of interpretation in a strict manner or with sound judgement on the case study results is demonstrated by means of the radar chart in Figure 5.12. The chart indicates that, for the Missouri River Levee Setback Project, repetitive interpretation in either a strict manner or with sound judgement results in relatively small differences in the percentage match to the criteria, with the exception of a 34 percent difference for the first criterion.

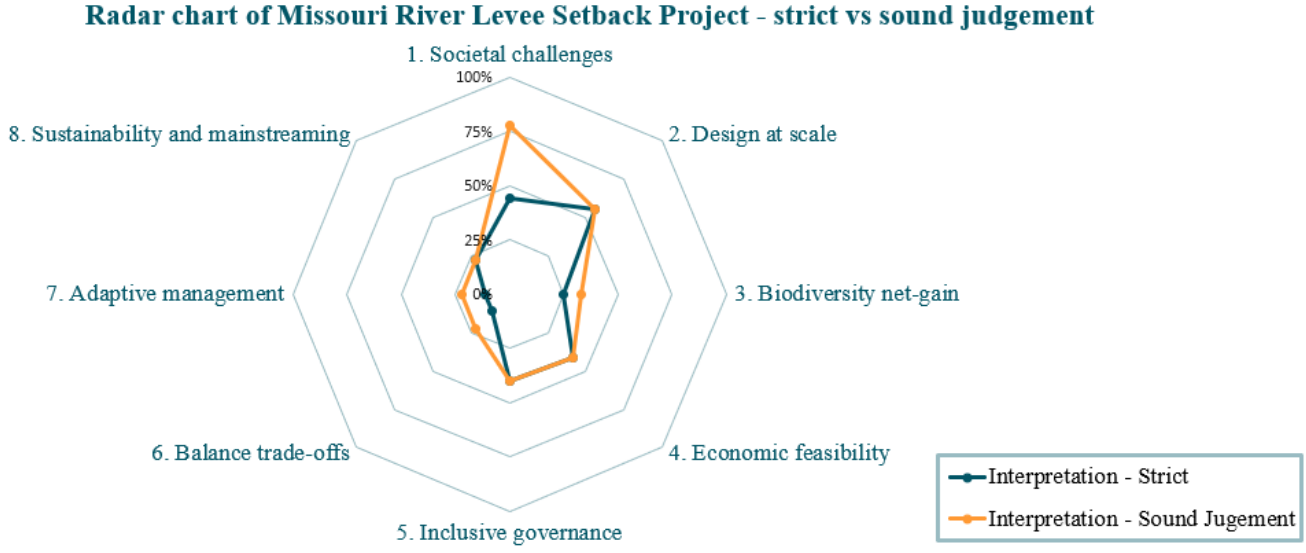


*Figure 5.12 – Radar chart of the percentage match of the Missouri River Levee Setback Project to the criteria of the IUCN Standard, for (i) a strict interpretation and (ii) an interpretation based on sound judgement.*

**Collection of contradictory data**

During data collection for the assessment of the Missouri River Levee Setback Project, contradictory data was collected. The following three scenarios were faced during the data collection procedure:

1. The data in two different publicly accessible documents contradict.
2. The data provided by the two interviewed project experts contradict.
3. The data in publicly accessible documents contradict with data provided by a project expert.

An example of the thirds scenario is the claim by Smith et al. (2017) that "native flora and fauna have responded with increased growth and abundance after implementation of the levee setback" (p. 42), which contradicts with the data provided by the project expert who stresses that certain claims cannot be made due to the limited monitoring. As similar situations occurred for other indicators, the case study results would have been different and less accurate if no expert interviews had been conducted. The collection of contradictory data resulted in additional time and effort that was spent on the assessment.

**Absence of stakeholder interviews**

As stated in section 2.3, no stakeholder interviews were conducted in the data collection for assessment of the Missouri River Levee Setback Project. As result, a challenge was faced in answering and/or substantiating one or more of the guiding questions of indicators 5.1, 5.3, 6.2 and 8.1. An example is one of the guiding questions of indicator 5.1, which is defined as follows:

*"Is the ownership and trust of the (feedback and grievance resolution) mechanism evident?"*

Based on data from publicly accessible documentation and expert interviews, the assessment was made that affected stakeholders have limited ownership and trust in the possibilities to provide feedback and grievance. As result of the absence of stakeholder interviews, this assessment is less accurate and lacks substantiation. However, as all of the other guiding questions were answered adequately with data from publicly accessible documentation and expert interviews, the indicator could still be evaluated. The same applies to the other indicators for which this challenge was faced.

## 5.5 Comparison and reflection

In this section, the results of the three case study assessments, covered in sections 5.2 to 5.4, are compared and reflected upon in order to make statements on the added value that the results may provide to stakeholders (section 5.5.1) and the challenges in assessment with the IUCN Standard (section 5.5.2).

### 5.5.1 Added value of the results

The reflection on the added value that the case study results may provide to stakeholders is divided into the three types of deliverables: (i) the total percentage match and adherence to the IUCN Standard, (ii) the strenghts and weaknesses of the project and (iii) the radar chart. The considered stakeholders include people involved in the project on which the IUCN Standard is applied and people working on NbS through different ways, who may benefit from the assessment. Furthermore, the reflection is based on literature research and consultation of project experts, which is covered in sections 5.2.3, 5.3.3 and 5.4.3.

**Added value – Total percentage match and adherence to the IUCN Standard**

The total percentage matches of the case studies to the IUCN Standard and the statements on whether these qualify as a NbS (i.e., are in adherence to the IUCN Standard) are summarized in Table 5.7.

*Table 5.7 – Total percentage match to the IUCN Standard and qualification as NbS for the three case studies.*

| Case study | Total percentage match [%] | Qualification as a NbS |
|---|---|---|
| 1 – Eddleston Water Project | 65 | Yes |
| 2 – RfR Deventer Project | 63 | Yes |
| 3 – Missouri River Levee Setback Project | 38 | No |

As stated in section 3.3.1, the IUCN Standard is a process-oriented framework. Therefore, the total percentage match to the IUCN Standard indicates the extent to which the essential processes of a NbS, established by the IUCN, have been incorporated in the project. These essential processes refer to, among others, up-to-date risk management, regular biodiversity monitoring, inclusive and equitable stakeholder participation and continuous adaptive management. The total percentage match does, however, not provide insight into the results of the project. If a project has at least a twenty-five percent match to each of the eight criteria, it is in adherence to the IUCN Standard and qualifies as a NbS according to the norm of the IUCN. Ultimately, the adherence to the IUCN Standard and qualification as a NbS can be interpreted as a stamp of quality that is given to a project if it has incorporated a sufficient amount of essential processes of a NbS, considered by the IUCN, to effectively and adaptively address societal challenges and simultaneously provide human well-being and biodiversity benefits.

A non-exhaustive list of ways in which a high total percentage match and/or qualification as a NbS may provide added value to stakeholders is presented in Table 5.8. On the other hand, a relatively low percentage match and/or no qualification as a NbS can provide added value to the project organization by raising awareness that the project has not been set up in line with the guidelines for an effective NbS, as established by the IUCN. This awareness may lead to future efforts of strengthening the robustness of (i) the project itself (if upscaling), or (ii) future projects by either learning from the identified weaknesses and/or using the IUCN Standard as guidance (i.e., ex-ante application).

*Table 5.8 – The added value of a high total percentage match to the IUCN Standard and/or qualification as a NbS, which should be read from left to right, following the horizontal lines.*

<table>
<tr><td colspan="5">A high total percentage match and/or qualification as NbS provides added value to:</td></tr>
<tr><td>Who - stakeholders</td><td colspan="4">How – added value</td></tr>
<tr><td rowspan="5">the project organization</td><td>by confirming</td><td>themselves</td><td></td><td></td></tr>
<tr><td>by revealing</td><td></td><td></td><td>making it a strong candidate for upscaling (IUCN, 2020b, p. 26)</td></tr>
<tr><td rowspan="3">by ensuring</td><td>(potential) funders and investors</td><td rowspan="3">that the project has incorporated essential processes of a NbS</td><td>in order to acquire additional funding (IUCN, 2020b, p. 25)</td></tr>
<tr><td>involved and affected stakeholders</td><td>in order to obtain support for the continuation of maintenance/monitoring and/or upscaling of the project</td></tr>
<tr><td>policy makers</td><td>in order to acquire support for upscaling and/or setting up similar projects in the future</td></tr>
<tr><td rowspan="2">“the development of the NbS concept”</td><td></td><td></td><td></td><td>in order to bring science on NbS into policy (i.e., mainstreaming)</td></tr>
<tr><td rowspan="3">by providing credibility</td><td colspan="2" rowspan="3">that the assessed project is a well-founded example of how to design, implement and monitor a NbS</td><td>to inspire people and/or organizations to initiate NbS projects, and improve and scale up existing NbS projects</td></tr>
<tr><td>people and/or organizations that are planning to or have initiate(d) NbS projects</td><td>such that it can be used for inspiration and guidance</td></tr>
<tr><td>contractors</td><td colspan="3">to their references in tenders for future projects</td></tr>
</table>

**Added value – Strenghts and weaknesses of the project**

Assessment with the IUCN Standard discloses the components of the indicators (i.e., guiding questions) that the project is in line with (i.e., strenghts) and is not in line with (i.e., weaknesses). A non-exhaustive list of ways in which the identification of strenghts and weaknesses of a project by assessment with the IUCN Standard may provide added value to stakeholders is presented on the following page.

The identification of **strenghts of the project** can potentially provide **added value** to:

- the project organization by ensuring that certain project components are incorporated completely in line with the IUCN Standard, which can provide confirmation and/or help in the interactions with policy makers, funders, investors, and involved and affected stakeholders (see Table 5.8).

- people and/or organizations that are upscaling or setting up a (NbS) project by disclosing the project components that are suitable for inspiration and/or guidance purposes.

The identification of **weaknesses of the project** can potentially provide **added value** to:

- the project organization by disclosing opportunities for improvement or alleviation of the weaknesses, helping to further strengthen the robustness of the (upscaled) project as a strong NbS.

- the project organization and/or clients by raising awareness about the learning opportunities within their previous project(s).

- people and/or organizations that are upscaling or setting up a (NbS) project by disclosing the project components that require additional attention, such that there are incorporated in a more complete and effective manner that is in line with the IUCN guidelines for an effective NbS.

### Added value – Radar chart

The third deliverable of an assessment with the IUCN Standard is a radar chart that displays the percentage match to each of the criteria, which for the three case studies is provided in Figure 5.13. Even though the Eddleston Water Project and RfR Deventer Project have approximately the same total percentage match, the shape of the radar charts is significantly different. The different shapes are the result of differences in the criteria (i.e., topics) of the IUCN Standard to which the projects, generally, do and do not comply to and can potentially be used to characterize the type of project.

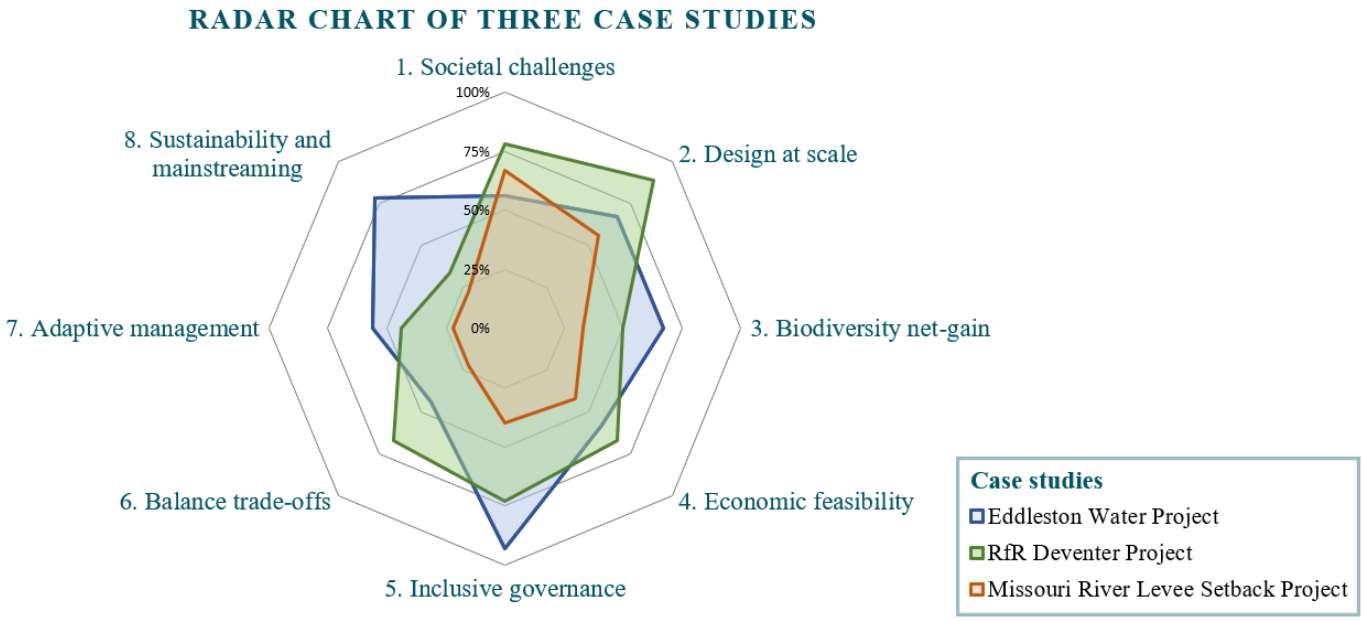


*Figure 5.13 – Radar chart of the three case studies to the criteria of the IUCN Standard.*

The shape of the radar chart of the Eddleston Water Project is distinct from the other case studies and can potentially be defined as an "inverted triangle" in having a high percentage match to criterion 5 and a relatively low percentage match to criteria 4 and 6. Characteristic to this shape is the high percentage match to Criterion 5 "Inclusive governance", which based on the case study results, is hypothesized to signify two project characteristics: (i) small surface area and (ii) informal stakeholder engagement. According to the interviewed experts, equitable participation among stakeholders can more easily be

achieved for a project with a relatively small surface area, such as the Eddleston Water Project, than for projects that cover a large surface area, which are likely to affect more people, distributed over a larger area and with different interests. Coherent to the small surface area is the role of Tweed Forum as a trusted intermediate to engage with stakeholders in an informal manner, which may also contribute to inclusive governance. The downside of the informal stakeholder engagement is that trade-offs are not elaborately assessed and documented, reflected by the low percentage match to the sixth criterion.

The shape of the radar charts of the other two case studies is similar and can potentially be defined as a "parallelogram" with a high percentage match to criteria 1 and 2, and a low percentage match to criteria 3, 7 and 8. Based on the case study results, the hypothesis is that this shape is characteristic for a project that is part of a (national) implementation program. As part of a (national) program, the projects address the most urgent challenges with a thorough understanding of their drivers, as reflected by the high percentage match to the first criterion. A characteristic of a pure implementation program is that the project team is disbanded after implementation and (organized) monitoring of project impacts is lacking. This is reflected by the low percentage matches to criterion 3, revealing limited biodiversity monitoring, and criteria 7 and 8, which reveal limited adaptive management and sharing of knowledge as result of no (organized) monitoring. The Missouri River Levee Setback Project, which aims to complete implementation as fast as possible, is an extreme example of such a project. This is reflected by the radar chart dropping below the twenty-five percent circle, signifying that the project does not qualify as NbS.

Identification of the characteristic shape of the radar chart can potentially provide **added value** to:

- the project organization by revealing the criteria (i.e., topics) to which the project does (not) comply, as well as the project characteristics that drive this compliance, which may help to concretize and address its weaknesses when upscaling or setting up similar projects.

- the project organization by providing the possibility to relate to projects with similar characteristics, allowing to learn from the barriers overcome and lessons learnt during these projects.

- the project organization by providing the possibility to compare to projects that have a higher percentage match to certain criteria, potentially providing learning opportunities.

### 5.5.2 Challenges in application

An overview of the challenges faced during the case study assessments is provided in Figure 5.14, in which a distinction is made between substantial challenges to a succesfull assessment and elements that provide valuable information, but are not substantial challenges, indicated with "!" and "i", respectively.

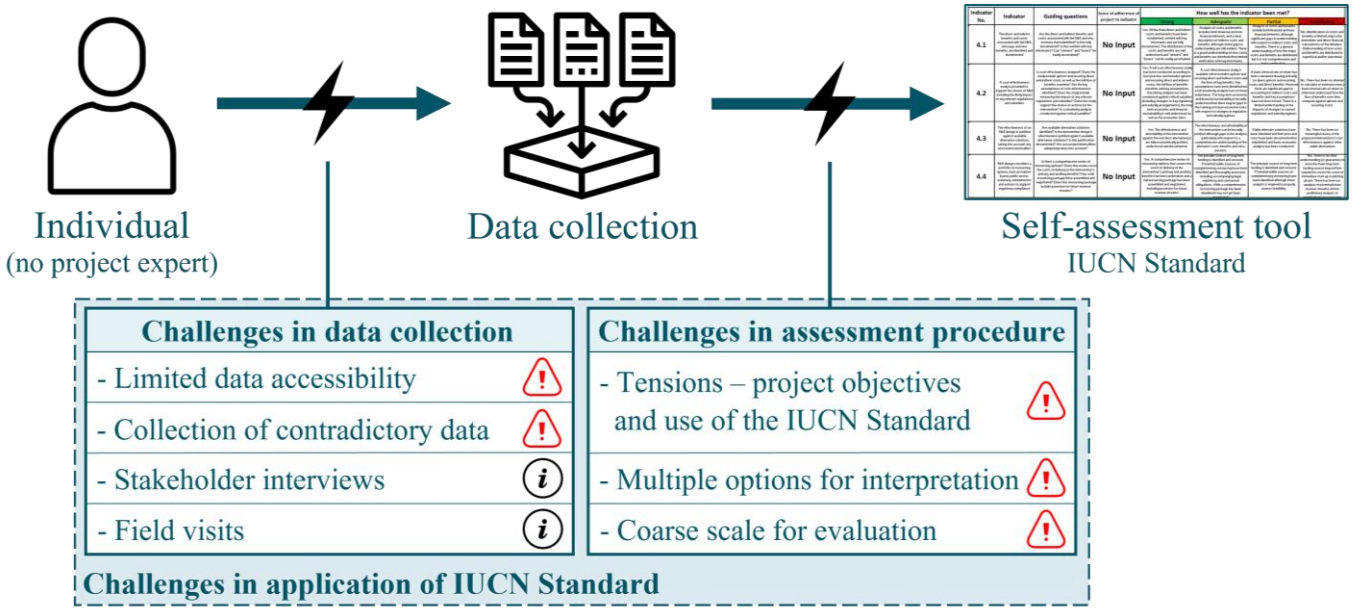


*Figure 5.14 – Challenges faced in application of the IUCN Standard to the three case studies.*

Each of the challenges in application is compared for the three case studies and evaluated below.

**Limited data accessibility & Collection of contradictory data**

One of the most significant features of river restoration projects, selected in section 4.3, is the data accessibility. To analyse the influence of the data accessibility on the applicability of the IUCN Standard, the Eddleston Water Project, RfR Deventer Project and Missouri River Levee Setback Project were selected to differ in the amount of publicly accessible documentation in decreasing order, as indicated in Table 5.1. The means of verification for the case studies, as illustrated in Figure 5.15, confirms this difference for the accessibility of the required data for assessment with the IUCN Standard. Furthermore, the figure illustrates that the required data for completion of all indicators of the IUCN Standard was accessible and collected by means of publicly accessible documentation and interviews with project experts (i.e., people closely involved in planning, managing or researching the project) and stakeholders (i.e., people directly affected by the project) for all three case studies.

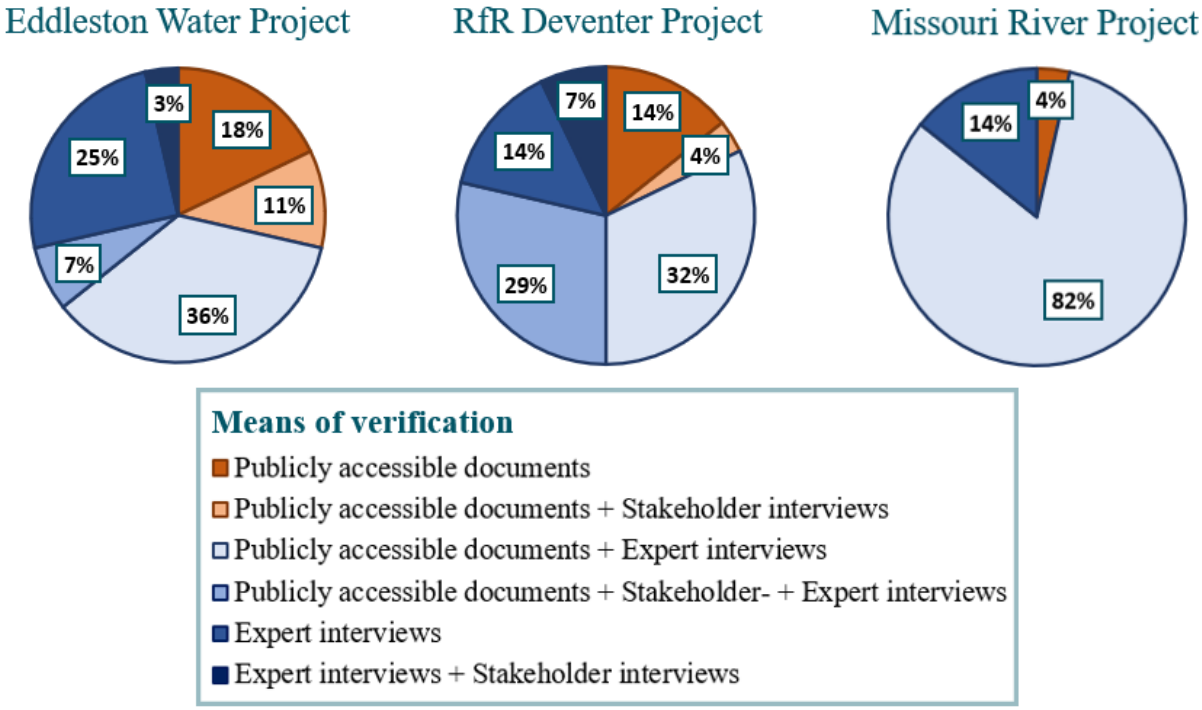


*Figure 5.15 – Distribution of means of verification for indicators during the three case study assessments, where the blue and orange colour shades refer to verification with and without expert interviews, respectively.*

The amount of indicators for which additional data was required from project experts is the largest for the Missouri River Levee Setback Project and smallest for the Eddleston Water Project. As no stakeholder interviews were conducted for the Missouri River Levee Setback Project, the data collected in stakeholder interviews for the other case studies, was collected in the expert interviews. Despite differences in the data accessibility, at least seventy-one percent of the indicators was (partly) verified through expert interviews for all case studies. Since insufficient data required for assessment with the IUCN Standard is publicly accessible, communication with project experts is found to be essential.

The percentage of indicators that involved data collection through expert consultation for application of the IUCN Standard on the Eddleston Water Project *(seventy-one percent)* is significantly larger than for the application of the framework by Andrikopoulou (2020) *(thirty-one percent)*. This large difference can be explained by the orientation of the frameworks: the framework by Andrikopoulou *(results-oriented)* and the IUCN Standard *(process-oriented)* requires data on, respectively, the project results and processes. As the publicly accessible documentation on the Eddleston Water Project includes more data on results than processes, less expert consultation was required for data collection for the framework by Andrikopoulou. In contrast to the Eddleston Water Project, which has extensive monitoring, the

available data on the results of projects with minimal monitoring, such as the RfR Deventer Project and Missouri River Levee Setback Project, is likely to be limited, which may pose challenges in data collection for results-oriented frameworks. As project experts generally have knowledge on most of the project processes, even though expert consultation is found to be essential, all of the required data for application of the IUCN Standard to projects with and without monitoring was collected.

Data accessibility does not only refer to the possibility, but also to the ease of data collection. In general, the required data for assessment of all case studies was collected relatively easily by solely accessing publicly accessible documentation and interviewing project experts and stakeholders. Between the three case studies, differences in the ease of data collection were experienced. Where the Eddleston Water Project consists of an elaborate database of project-related documentation, data for the RfR Deventer Project and Missouri River Levee Setback Project were collected through various different websites and documents. In addition, contradictory data was collected for the last mentioned case study. These difficulties increased the amount of time and effort that was spent on the assessments.

### Stakeholder interviews

In order to identify whether the ability to collect data from stakeholders, referring to people that are directly affected by the project, influences the applicability of the IUCN Standard, the amount of stakeholder interviews differs between the case studies. A number of guiding questions reflect upon stakeholder opinions, such as the following question of indicator 5.3:

*"Do affected stakeholders accept and feel ownership over the outcomes of the intervention?"*

The indicators for which both the Eddleston Water Project and RfR Deventer Project required data from stakeholders are: 1.1, 5.1, 5.2, 5.3, 6.2 and 8.1. In addition, indicators 2.1, 3.2, 3.3, 5.4 and 7.3 were also verified by stakeholder interviews for the assessment of the RfR Deventer Project, which can be explained by the smaller amount of publicly accessible data. As stated in section 5.4.4, the lack of data from stakeholder interviews posed a challenge in evaluating the Missouri River Levee Setback Project on indicators 5.1, 5.3, 6.2 and 8.1, which coincide with the indicators that were verified with stakeholder input for the other case studies. Based on assessment of this project, the inability to communicate with stakeholders does not pose a substantial challenge in application of the IUCN Standard, provided that sufficient data can be collected through other sources. Furthermore, based on the three case study assessment, it is identified that the amount of stakeholder interviews influences the degree of substantiation and potentially the accuracy of an assessment with the IUCN Standard.

### Field visits

Furthermore, in order to identify whether a field visit to the project location has an influence on the applicability of the IUCN Standard, the data collection for the three case studies included a field visit of three days, a half day and no field visit. Even though no field visit was conducted for the Missouri River Levee Setback Project, all required data was collected through publicly accessible documentation and digital communication with stakeholders and project experts. Based on this finding, the inability to conduct a field visit does not pose a challenge in application, as long as digital communication with interviewees is possible. The field visits for the other case studies, however, did increase the ease of data collection, as it was significantly easier to reach out to stakeholders and experts, and helped with a better understanding of the project context, which is beneficial in conducting the assessment.

### Tensions between project objectives and use of the IUCN Standard

Tensions are identified between the objectives of the case studies and the typical project for which the IUCN Standard is set-up, resulting in situations in which it is arguable whether the projects would benefit from pursuing the steps to achieve higher scores and thereby improve or alleviate the "weaknesses" identified by the assessment. The project objectives of the three case studies that are in tension with the use of the IUCN Standard are listed on the following page.

**Project objectives in tension with the IUCN Standard:**

1. Research project, which aims to research the effectiveness of certain measures as detailed as possible and does not seek return on investment.
2. Project with flood risk mitigation as its main objective.
3. Project with informal stakeholder engagement, based on trust.
4. Long-term project that initiates monitoring of certain elements at later project stages.
5. Project that is part of and contributes to the objectives of a (national) program.
6. Project that aims to achieve maximum effect within a fixed budget.
7. Emergency rehabilitation project, which aims to be executed as soon as possible.

The second project objective applies to all projects that fit the scope of the research. As covered in section 5.2.4, the IUCN Standard cannot be used to evaluate whether targets, benchmarks and monitoring are established for flood risk mitigation. In addition, it cannot be used to evaluate the contribution to flood risk mitigation, as it is as process-oriented framework. The only means by which flood risk mitigation is potentially evaluated within the IUCN Standard is indicator 1.1, which evaluates whether the most pressing societal challenges are prioritized. This implies that a river restoration project that prioritizes the most pressing challenge of flood risk and has specific and measurable targets for regular monitoring of flood risk mitigation would have the same total percentage match to the IUCN Standard as an identical project that did not establish targets, benchmarks and monitoring.

### Multiple options for interpretation

Certain indicators and accompanied guidance can be interpretated in multiple ways, differing for the three case studies. This can be the result of (i) an insufficient amount of details in the guidance or (ii) the possibility to interpret the indicator in either a strict manner or with sound judgement. Interpretation of the relevant indicators in a strict manner or with sound judgement did not result in significantly different results for the Eddleston Water Project, while it did for the RfR Deventer Project (criteria 1 and 7) and the Missouri River Levee Setback Project (criterion 1), as covered in sections 5.2.4, 5.3.4 and 5.4.4. This implies that, depending on the specifics of the project, repetitive interpretation in either a strict manner or with sound judgement can lead to significantly different results, which may ultimately influence whether a project does (not) qualify as a NbS.

### Coarse scale for evaluation

The IUCN Standard has a semi-quantitative scale of four options (*strong, adequate, partial and insufficient*) for the evaluation of its indicators. A challenge that was occasionally faced during the case study assessments is that two case studies with a different level of adherence to an indicator were still provided with the same score, as this was most suitable for both. This indicates that the scale of four options is too coarse to accurately capture the differences between projects.

# 6. Discussion

This chapter covers the discussion of the results obtained in the research. First, based on these results, a critical reflection on the use of the IUCN Standard is provided in section 6.1. Next, the limitations and relevance of the research are discussed in sections 6.2 and 6.3, respectively.

## 6.1 Use of the IUCN Standard

The identified assessment frameworks for NbS, listed in section 3.1, contradict with the claim of the IUCN that the IUCN Standard is "*the first-ever set of benchmarks for nature-based solutions to global challenges*" (IUCN, 2020c). Furthermore, the IUCN Standard consists of several debatable implications that a project that adheres to the standard qualifies as a NbS, such as the statement that *"past and ongoing NbS…can also be evaluated against the Standard's Criteria, if the intention is for the intervention to be recognized as an NbS"* (IUCN, 2020b, p. 11). Adherence to the IUCN Standard means that a sufficient amount of essential processes of a NbS, such as inclusive and equitable stakeholder participation and continuous adaptive management, have been incorporated in a project. It does, however, not provide insight into the effectiveness of a project. Therefore, claiming that a project qualifies as NbS if it adheres to the IUCN Standard may mislead people into thinking that a project is effective in providing benefits associated with NbS, while this is not certain. Misinterpretations can be avoided by framing the result as "being in adherence to the IUCN Standard", rather than "qualifying as a NbS", as confirmed by an expert of the Missouri River Levee Setback Project in section 5.4.3.

The most significant shortcomings and benefits of the IUCN Standard, identified by relating the standard to other frameworks for NbS (*sub-question 1 – Chapter 3*), are verified by the results of the case study assessments (*sub-question 3 – Chapter 5*) in Table 6.1. In this table, "yes" implies that the shortcoming or benefit is confirmed by the case study assessments, while "no" does not necessarily imply that it is not a shortcoming or benefit, but solely that it has not been confirmed by the case study assessments.

*Table 6.1 – Verification of shortcomings and benefits of the IUCN Standard by the results of the case study assessments.*

| **Shortcomings of the IUCN Standard** | **Verified** |
|---|---|
| - Broad language and guidance / No sector-specific topics | **no** |
| - Limited flexibility to tailor assessment (e.g., to project context) | **yes** |
| - Susceptible to human errors (due to semi-quantitative input) | **yes** |
| - Limited provision of credibility (due to descriptiveness) | **no** |
| - No insight into project results | **yes** |
| - Limited guidance on resources for evaluation | **no** |
| - No evaluation of targets & monitoring for project objectives | **yes** |
| **Benefits of the IUCN Standard** | **Verified** |
| - Broad applicability | **no** |
| - Provision of statements such as the "total percentage match" | **yes** |
| - Easy data collection | **yes** |
| - Evaluation of project processes | **yes** |
| - Incorporation of stakeholder input in the assessment | **yes** |
| - Few competences required of assessors | **yes** |

As stated in section 1.1.5, the IUCN Standard is established in an attempt to develop a global and common assessment framework for NbS. Theoretically, this is confirmed by the broad applicability in relation to other frameworks, however, as indicated in Table 6.1, the case study assessments do not verify this. The results of the case study assessments confirm that the IUCN Standard is applicable to river restoration projects in several developed countries, varying in their most significant features. This makes it likely that the standard is applicable in other sectors (e.g., urban) and developing countries, but

definitive statements require application to the specific sectors and/or countries. Furthermore, the verification of shortcomings and benefits of the IUCN Standard in Table 6.1 and further results of the case study assessments reveal several limitations in the use of the standard. Together with suggestions or dilemmas for potential adjustments to the IUCN Standard, these limitations are discussed below.

**Suggestions – Limitations in the use of the IUCN Standard**

Even though the IUCN Standard is applicable to river restoration projects, the usefulness of its application is limited, because the IUCN Standard only includes indicators that evaluate whether targets and monitoring are established for human well-being and biodiversity objectives, and falls short in evaluating these processes for other project objectives. Specific to projects with a focus on flood risk mitigation, as is the case for most river restoration projects in the Netherlands, this implies that the IUCN Standard cannot be used to evaluate whether targets and monitoring are established for flood risk mitigation, which is confirmed by the identified tension in the case study assessments. As result, the IUCN Standard cannot be used to identify strenghts and weaknesses in the processes for flood risk mitigation, which results in missed opportunities for upscaling and improving the assessed project. This limitation in the use of the IUCN Standard can potentially be overcome by adding an additional criterion, which similar to Criterion 3 "Biodiversity net-gain", evaluates whether targets, benchmarks and regular monitoring are established for the societal challenge(s) that the project aims to address.

Another limitation in the use of the IUCN Standard is that the twenty-five percent match to each of the criteria as a requirement for a project to be in adherence to the IUCN Standard (and qualify as a NbS) is relatively low and that, as result, there can be a large difference in the quality of two projects that are both in adherence to the standard. This poses a challenge to the comparison between projects. A suggestion to reduce this difference is to never phrase the final result as "being in adherence to the IUCN Standard", but to always include the degree of adherence (*partial: 25 – 50%, adequate: 50 – 75%, or strong: 75 – 100%*). Lastly, a limitation specific to the use of Criterion 5 "Inclusive governance" is that the fifth indicator suggests that a project that has identified the project area to not extent beyond jurisdictional boundaries has a "strong" match to the indicator. As result, this implies that a project that has very limited inclusive governance, but does not extent beyond jurisdictional boundaries, can still receive a higher than twenty-five percent match for the criterion, as demonstrated by the evaluation of the Missouri River Levee Setback Project in section 5.4.3. A suggestion to avoid that, as a result, projects are unfairly in adherence to the IUCN Standard is to provide the option for a "neutral" score for indicator 5.5, which allows to skip the indicator if a project does not extent beyond jurisdictional boundaries.

**Dilemmas – Limitations in the use of the IUCN Standard**

A major shortcoming of the IUCN Standard that follows from the literature study is the limited flexibility in assessment that is provided to the user. If used as prescribed, the IUCN Standard requires completion of all criteria and indicators, and therefore does not provide the possibility to tailor the assessment to the project context. Despite its limited flexibility, the IUCN Standard has succesfully been applied to all case studies. However, as the assessment could not be tailored to the project context, the case studies were provided with low scores for the indicators that were irrelevant to the project context, resulting in cases in which it is arguable whether the case studies would benefit from pursuing the steps to achieve higher scores. This challenge in application is defined as a tension between the project objectives and the use of the IUCN Standard and confirms that the limited flexibility is a shortcoming of the IUCN Standard. These tensions may pose limitations in using the IUCN Standard as (i) one should not necessarily aim to achieve a one hundred percent match and (ii) a project can score below a twenty-five percent match to a criterion that is irrelevant to its context, while the percentage matches to all relevant criteria are sufficient. To rule this as not being in adherence to the IUCN Standard would be unjustified.

Using the IUCN Standard slightly different than intended by excluding the indicators that are irrelevant to the project context would prevent the evaluation of a project on elements that are irrelevant to its context and thereby omit these limitations. Considering the graph of the inventory of frameworks developed in section 3.1, this adjustment to the use of the IUCN Standard would position it more to the

right, as indicated with (a) in Figure 6.1. Increasing the flexibility in the use of the IUCN Standard even more by also incorporating additional criteria and indicators would allow to precisely tailor the assessment to the project context, positioning the standard at (b) in Figure 6.1. In practice, the exclusion and/or incorporation of criteria and indicators may be achieved with relatively simple modifications to the self-assessment tool of the IUCN Standard. A tailored assessment will produce results that are more specific to the project context, which may increase the added value that they provide.

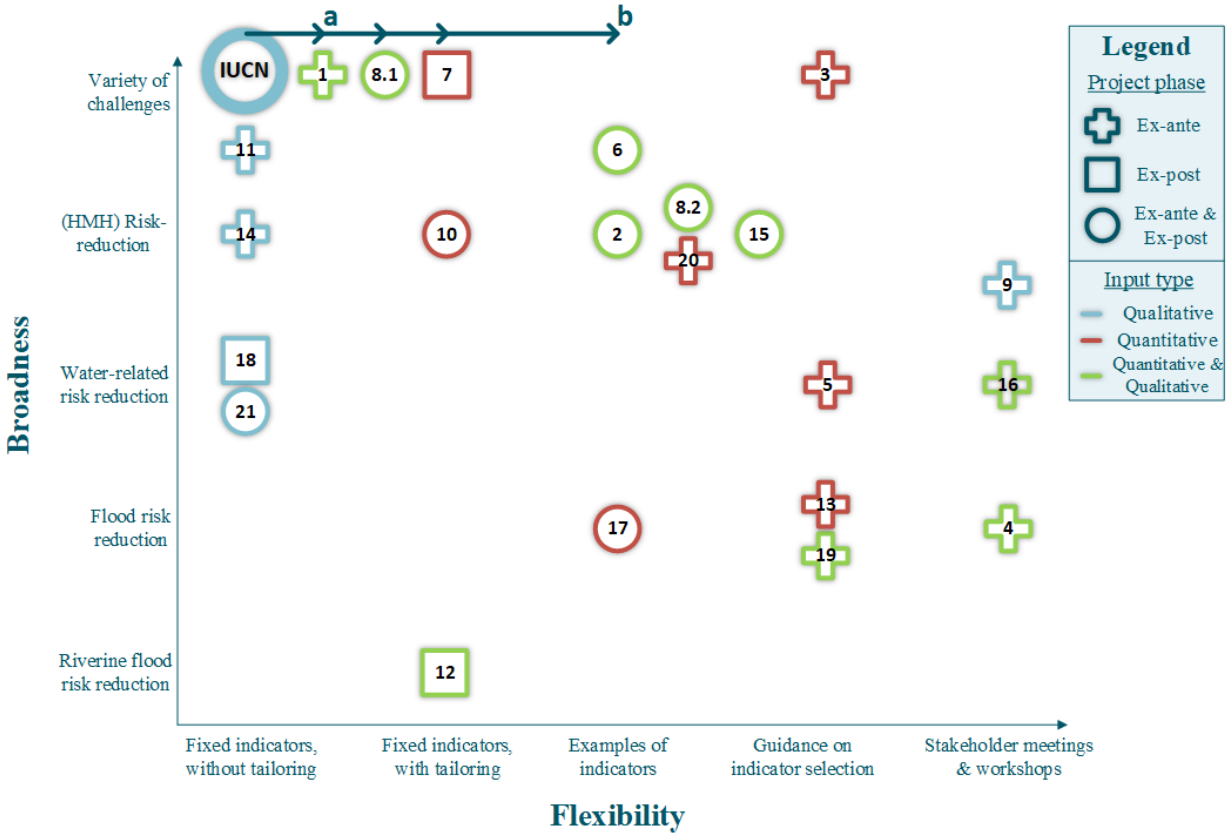


*Figure 6.1 – Graphical representation of the inventory of assessment frameworks for NbS, in which potential adjustments to the flexibility in assessment with the IUCN Standard are indicated.*

However, increasing the flexibility in assessment by excluding criteria and/or indicators would partly offset one of the benefits of the IUCN Standard, namely the provision of statements such as the "total percentage match". When certain criteria and/or indicators, which the IUCN recognizes as essential principles of NbS, are excluded, these statements lose their value. Therefore, there is a dilemma between increasing the flexibility in assessment, which would allow to tailor the assessment to the project context and prevent the evaluation of elements that are irrelevant, or using the IUCN Standard as intended, which allows to make statements on the total percentage match and adherence to the IUCN Standard.

Two other limitations in the use of the IUCN Standard are the multiple ways in which certain indicators can be interpreted and the relatively coarse scale for evaluation. As result of the multiple options for the interpretation of indicators, the results of an assessment with the IUCN Standard may be significantly different when performed by another individual. These differences in results may be reduced by increasing the level of detail in the indicator guidance. However, this is not a straightforward suggestion, as the room for interpretation might actually be very important for the IUCN Standard to be interpretable in different contexts and increasing the level of detail might therefore limit its scope of application. Furthermore, the semi-quantitative scale of four options for evaluation is identified as too coarse to accurately capture the differences between projects. Where this limitation may be reduced by providing more options for scoring, this does not necessarily improve the self-assessment tool, since more options may increase the difficulty in deciding which score to select and, as stated by Cooper & Johnson (2016), an uneven amount of options can be problematic as users tend to select the middle option.

## 6.2 Research limitations

The limitations of the literature study *(Chapter 3)* and the case study assessments *(Chapter 5)* are covered in sections 6.2.1 and 6.2.2, respectively. In both sections, a distinction is made between methodological constraints and other factors that may have influenced the results.

### 6.2.1 Limitations of the comparison of the IUCN Standard to other frameworks

The methodology for the literature research for frameworks consists of the following constraints:

- As the search terms for the NbS concept were limited to "NbS", "BwN" and "NFM", frameworks in which other terminologies are used may be missed.
- As the research was limited to articles published since 2016, frameworks that were published prior to 2016 and not identified through the Snowball Method are missed.
- Relevant frameworks that do not include the search terms provided in Table 2.1 and are not identified through the Snowball Method are missed.

Furthermore, a constraint on the methodology is that the analysis and comparison of the frameworks is solely based on their content, while the actual applicability and usefulness of a framework depends on the exact content and formulation of the tools for evaluation (e.g., indicators) and can only be determined by application of the framework. Therefore, a comparison of the applications of the IUCN Standard and other frameworks is required to make definitive statements on its shortcomings and benefits.

The requirements for the literature research, listed in section 2.1.1, are not clear-cut and frameworks on the border of meeting the requirements could therefore have (not) been included in the research dependent on the interpretation and decision of the researcher. Other factors that may have influenced the results are (i) the extent to which the different frameworks were analysed and compared to the IUCN Standard, which is likely to differ throughout the frameworks, and (ii) the selection of the three most relevant frameworks, which is dependent on how the researcher interprets the requirements and wishes listed in section 2.1.2. Lastly, a similar literature research and comparison may provide significantly different results when performed at another point in time, as the field of research is very dynamic.

### 6.2.2 Limitations of the case study assessments

The methodology of the case study research consists of the following constraints in corresponding steps:

- **Case study selection:** As result of the requirements imposed on the case study selection, the generalizability of the results is limited to projects that meet these requirements.
- **Data collection:** As the amount of project-related documentation that is analysed is limited to five to eight documents, certain publicly accessible data might have not been collected and therefore retrieved through interviews. This could have influenced the means of verification, presented in Figure 5.15, and associated conclusions on data accessibility.
- **Reflection on assessments:** As the evaluation of the added value of the case study results is based on literature review and interviews with experts of the case studies, further validation and substantiation of these findings might require additional research.

Several factors that may influence the case study selection and data collection, therefore potentially having an impact on the case study and research results, are listed in Table 6.2. Additional factors that may influence the data collection are issues faced in the communication with experts (i.e., people closely involved in planning, managing or researching the project) and stakeholders (i.e., people affected by the project). An example within this research is the experience of a stakeholder that stopped replying.

Furthermore, the semi-quantitative scoring that is provided during assessment of a project with the IUCN Standard is influenced by how the user interprets the indicators and project context, as well as potential biases of the user. These influences are even larger for indicators for which multiple options for interpretation were explicitly identified, as elaborated upon in section 5.2.4. As result, the case study results may be significantly different when conducted by another individual. Even though this

susceptibility to the user will always exist, it has been reduced within this research by carefully reading the instructions and meeting with one of the authors of the IUCN Standard, such that misinterpretations on the assessment procedure were avoided as much as possible. The susceptibility to the user can also be reduced by independent assurance of other individuals conducting the assessment. This was not done, as it does not fit within the research scope of analysing the applicability and usefulness of the IUCN Standard when used by one individual that is not a project expert. As result, the case study results are limited in their accuracy and reproducibility. This, however, does not make the case study results invaluable, as through elaborate and transparent documentation of the rationale for scoring, as provided in Appendices E, F and G, the process of assesment is documented. This enables a different level of assesment, in which assessments with the IUCN Standard can be compared based on the documented processes (i.e., how the assessments were conducted). Lastly, the challenges faced during the case study assessments may be different when performed by another individual as result of a difference in foreknowledge on (i) processes related to NbS or (ii) the content and application of the IUCN Standard.

*Table 6.2 – Factors that may influence (a) case study selection and (b) data collection.*

| Case study selection | Data collection |
|---|---|
| - Selection of most relevant features of river restoration projects *(section 4.3)* | - Selection of project-related documentation |
| - Classification of types of NbS measures *(section 4.4)* | - Time and effort in identification of and scanning through project-related documentation |
| - Availability and accessibility of case studies in literature | - Amount and length of interviews and/or communication with experts and stakeholders |
| - Preferences of the researcher | - Knowledge of selected interviewees |
| - Final decision made by the researcher | - Biases of selected interviewees |

## 6.3 Research relevance

The relevance of the research results is discussed by comparison to the results of existing research and placement in the context of the development of the NbS concept in sections 6.3.1 and 6.3.2, respectively.

### 6.3.1 Comparison to existing research

In this section, the research results are compared to existing studies on the IUCN Standard, which are introduced in section 1.1.5. To begin with, the research by Pakeman et al. (2021) has a similar structure as the comparison of the IUCN Standard to other frameworks for NbS in Chapter 3. Most of the shortcomings and benefits of the IUCN Standard identified in Chapter 3 are in line with the findings of Pakeman et al. One of the main findings of Pakeman et al. is the identification of a tension between a framework that can be applied across all sectors and a more detailed framework that offers more support over a limited range of contexts. This finding is confirmed in this research by the differences between the IUCN Standard, which is widely applicable, and the framework by Andrikopoulou (2020), which offers more support, but is limited to riverine flood risk reduction. A shortcoming of the IUCN Standard identified by Pakeman et al. that did not follow from this research is the limited introduction into NbS, which is linked to the recommendation to read the handbook by Somarakis et al. (2019) prior to assessment with the standard. Where the research of Pakeman et al. is limited to the comparison of the IUCN Standard to other frameworks and recommends its application to case studies (in Scotland) to provide a template for others to follow, this research addressed this gap by application of the standard to the Eddleston Water Project and two other case studies (Pakeman et al., 2021).

The challenges faced during application of the IUCN Standard to the three case studies and the evaluation of the added value that this application may provide are compared to the findings of other applications of the standard. To begin with, the desk study by Le Gouvello et al. (2022) recommends that the case study assessment is collectivelly managed with local stakeholders and conducted at location. The findings of this research elaborate on these recommendations by identifying that the ability

to communicate with affected stakeholders increases the degree of substantiation and most likely the accuracy of the results, but is not essential for a legitimate assessment as long as sufficient data can be retrieved through other sources. Furthermore, this research identifies that field visits do increase the ease of data collection, but are not required if digital communication with project experts (and stakeholders) is possible. In the studies by Shina & Bimson (2021) and Risna et al. (2020), the IUCN Standard is applied to identify key points on which the project/concept can be strenghtened, which corresponds to the added value of applicaton of the standard identified in this research.

### 6.3.2 Development of the NbS concept

Nature-based Solutions is an increasingly popular and promising concept in, among others, future-proof riverscape development, but its development is held back by various barriers to succesfull implementation, as elaborated upon in section 1.1.3. This research focuses on the lack of a global and common framework for the implementation and evaluation of NbS. In section 1.1.4, it is hypothesized that such a framework for all types of NbS may provide a common grouping of terms and interchangeability in language, which can potentially increase the ease of communication between people working on NbS in different sectors and with different interests. This may be beneficial to successful implementation of NbS, as well as contribute to the next steps in the development of the concept: upscaling and mainstreaming. The IUCN Standard was published in an attempt to develop such a global and common framework, and thereby to contribute to the development of the NbS concept.

This research contributes to a better understanding of the applicability and usefulness of the IUCN Standard as a tool to evaluate (riverine) NbS, which was lacking in existing research. The research results demonstrate that the IUCN Standard is applicable to river restoration projects varying in scope and indicate the challenges that (i) should be kept in mind when using the standard and (ii) can potentially be reduced within its next updates. Furthermore, the results demonstrate various ways in which application of the IUCN Standard may provide added value in successfully implementing and upscaling NbS. The results in Chapter 3 indicate that no sector-specific terminology is included within the IUCN Standard, which implies that its terminology and guidance is broadly applicable, but the extent to which this contributes to the ease of communication between people working on NbS and what this would mean for upscaling and mainstreaming of NbS requires additional research. The research results do indicate that application of the IUCN Standard may contribute to mainstreaming by providing credibility to NbS projects in order to raise awareness of their value among policy makers. In addition, the results demonstrate that the IUCN Standard, if further optimized with regard to its limitations in section 6.1, has the potential to be a suitable tool for policy makers to evaluate whether a set of solutions for FRM includes a sufficient amount of processes that are in line with the standard of practice for NbS.

The processes of successful implementation, upscaling and mainstreaming of NbS are also in development within the organization of Rijkswaterstaat. From 2014 to 2020, Rijkswaterstaat was the project manager of the EU Interreg NSR BwN project, which aimed to provide scientific evidence of the benefits of coastal and riverine NbS, identified as one of the enablers to successful implementation in section 1.1.3 (Giovanni & Zevenbergen, 2019). As a follow-up, Rijkswaterstaat is currently involved in the submission of the new Interreg North-West Europe (NWE) project “ResiRiver” that focuses on the upscaling and mainstreaming of riverine NbS with the final objective of ensuring that water authorities use NbS as standard practice (Wilson, 2022). This research and the IUCN Standard can potentially contribute to this project in the ways described above.

# 7. Conclusion and Recommendations

This chapter provides an answer to the research questions in section 7.1 and recommendations for the application of the IUCN Standard and future research in section 7.2.

## 7.1 Conclusion

The main objective of this research was to determine whether the IUCN Global Standard for NbS can effectively be applied for ex-post assessment of river restoration projects with a focus on flood risk mitigation, captured in the following main research question:

**Which challenges occur in the application of the IUCN Global Standard for NbS on river restoration projects with a focus on flood risk mitigation, and what added value does this application provide to stakeholders?**

The stakeholders for whom the added value of applying the IUCN Standard is determined include people involved in the project on which the standard is applied and people working on NbS through different ways (e.g., people involved in other NbS projects). First, each sub-question is answered individually, after which the answer to the main research question is formulated.

**1. How does the IUCN Global Standard for NbS relate to other assessment frameworks for NbS that deal with physical interventions for riverine flood risk mitigation?**

In this research, the content of the IUCN Standard is related to twenty-two assessment frameworks for NbS that deal with physical interventions for riverine flood risk mitigation and compared in-depth to the frameworks by Andrikopoulou (2020), Dumitru & Wendling (2021a) and Huthoff et al. (2018). The results indicate that, in relation to the identified frameworks, the IUCN Standard has been set up to have a large broadness in application to a variety of societal challenges, sectors, scales and project phases. Furthermore, the IUCN Standard provides limited flexibility to its users by not providing possibilities to tailor the assessment to the project context or preferences of the user and, in contrast to most other frameworks, strictly requires semi-quantitative input with qualitative rationale.

Based on the in-depth comparisons, it can be concluded that the IUCN Standard can be used as a tool for the evaluation of the processes throughout the phases of a project (i.e., process-oriented). The evaluated processes include, among others, risk management, targeting and monitoring, stakeholder engagement and adaptive management. The IUCN Standard can, however, not be used for the evaluation of the project results, refering to biophysical, as well as social, institutional and stakeholder results. In contrast, the frameworks by Andrikopoulou (2020) and Dumitru & Wendling (2021a) are restricted to the evaluation of the results of a project (i.e., results-oriented). The comparisons also indicate that the main shortcomings of the IUCN Standard are the limited guidance on resources for evaluation and lack of sector-specific topics, although both did not pose challenges in the case study assessments. Lastly, based on the comparisons and case study assessments, it can be concluded that main benefits of the IUCN Standard with respect to the other frameworks are the few required competences of assessors and the possibility to incorporate input from stakeholders that are affected by the assessed project.

**2. What are the most relevant physical and non-physical features, based on which river restoration projects can be classified?**

By identifying the most relevant features, based on which river restoration projects can be classified, the research aims to yield valuable results from comparison of case studies that differ in these features. Based on literature review, it can be concluded that the most relevant features, based on which river restoration projects can be classified are the **surface area, position in the catchment, kinetic energy of the river, data accessibility and resources**, although these were selected with the research purposes in mind. In addition, this research has shown that the specific NbS measures that are actually implemented in a project are dependent on many features and a decision made by individuals, and

therefore take place at a higher level in the characterization of river restoration projects than the individual features. Therefore, the **types of riverine NbS measures** are also considered as a relevant element, based on which river restoration projects can be classified and in which the case studies require to differ. For this purpose, the types of riverine NbS measures are classified into the following five categories: floodplain reconnection, river planform adjustments, planting or removal of vegetation, in-channel interventions and interventions in the floodplain.

**3. Which challenges are identified by applying the IUCN Global Standard for NbS to case studies, and what added value does this application provide to stakeholders?**

The Eddleston Water Project, Project "Room for the River" Deventer and the Missouri River Levee Setback Project are selected as case studies of river restoration projects with implemented NbS measure(s) and a focus on flood risk mitigation, of which at least two differ in the most relevant features and types of riverine NbS measures. By ex-post application of the IUCN Standard to the three case studies, this research has identified four types of challenges in application of the standard and a number of ways in which three types of results following from the application may provide added value to stakeholders. The four types of challenges faced in application are as follows:

- Tensions between project objectives and the use of the IUCN Standard, reflected in:
    - cases in which it is arguable whether the project would benefit from pursuing the steps to improve the identified weaknesses.
    - the very limited evaluation of processes related to flood risk mitigation.
- Multiple options for interpretation of certain indicators and accompanied guidance, which, dependent on the project characteristics, may lead to significantly different results.
- Increased amount of time and effort spent on data collection due to: (i) limited data accessibility in terms of ease of data retrieval and (ii) collection of contradictory data.
- The inability to indicate differences in the evaluation of projects due to the semi-quantitative scale of only four options.

In addition, the results indicate that consultation of project experts (i.e., people closely involved in planning, managing or researching the project) is essential to collect all required data for application of the IUCN Standard. The results also indicate that the inability to communicate with stakeholders that have been affected by the project does not pose a substantial challenge in application, but does influence the degree of substantiation and potentially the accuracy of the assessment. Lastly, it is found that the inability to conduct a field visit does not pose a challenge in application either, however, a field visit can increase the ease of data collection and help with a better understanding of the project context.

The three types of results following from assessment with the IUCN Standard and the respective added value that these may provide, based on project expert consultation and literature review, are as follows:

1. **Result:** Total percentage match of the project to the IUCN Standard and, depending on the used terminology, a statement on being in adherence to the standard and/or qualifying as NbS.
   **Added value:** Provide credibility that a sufficient amount of essential processes of a NbS, as established by the IUCN, have been incorporated in the project. These essential processes refer to, among others, up-to-date risk management, regular biodiversity monitoring, inclusive and equitable stakeholder participation, and continuous iterative learning and adaptive management.

2. **Result:** Project components that are in line (i.e., strenghts) and are not in line (i.e., weaknesses) with the guidelines of essential processes for NbS provided in the IUCN Standard.
   **Added value – strenghts:** Provide confirmation, and inspire and/or guide (NbS) projects.
   **Added value – weaknesses:** Provide opportunities for improvement of the (upscaled) project and/or strengthening future (NbS) projects.

3. **Result:** A radar chart with the percentage match to each of the eight criteria of the IUCN Standard.
   **Added value:** Provides possibilities to compare to and learn from other (NbS) projects.

Main research question:

**Which challenges occur in the application of the IUCN Global Standard for NbS on river restoration projects with a focus on flood risk mitigation, and what added value does this application provide to stakeholders?**

The IUCN Standard can be used as a tool to evaluate whether the processes throughout the phases of a project are in line with the essential processes for a NbS, as established by the IUCN. As a framework that can be used to evaluate project processes, but cannot be used to evaluate the results of a project, the IUCN Standard is defined as a *process-oriented framework*. When a project is in adherence to the IUCN Standard, it has incorporated a sufficient amount of essential processes, considered by the IUCN, to effectively and adaptively address societal challenges and simultaneously provide human well-being and biodiversity benefits. These essential processes include, among others, regular biodiversity monitoring, inclusive and equitable stakeholder participation and continuous adaptive management.

Based on the relation of the IUCN Standard to other frameworks for NbS and the ex-post application to three case studies, it can be concluded that:

- despite of a few challenges, the IUCN Standard is applicable to river restoration projects with a focus on flood risk mitigation, requiring few competences of users and providing the option to incorporate input from affected stakeholders.
- application of the IUCN Standard may provide added value by providing (i) credibility to the processes of a project, (ii) insights into the strenghts and weaknesses of a project, and (iii) possibilities for comparison with other projects, although restricted by the limited evaluation of flood risk mitigation.

## 7.2 Recommendations

Recommendations for the application of the IUCN Standard in practice and policy-making, and suggestions for future research are provided in sections 7.2.1 and 7.2.2, respectively.

### 7.2.1 Recommendations for application of the IUCN Standard

Based on the conclusions, it is recommended that practitioners use the self-assessment tool of the IUCN Standard for ex-post evaluation of a (river restoration) project for one or more of the following reasons:

- Provide credibility to the processes of a project, in order to:
    - acquire additional funding for upscaling and/or setting up a new (NbS) project.
    - acquire support from policy makers, and involved and affected stakeholders.
    - inspire the initiation of new (NbS) projects and upscaling of ongoing (NbS) projects.
    - help convince policy makers that NbS should always be part of a full set of solutions for FRM problems (i.e., mainstreaming).
- Identify strenghts of a project and/or a high percentage match to the standard to provide confirmation and reveal the project as a strong candidate for upscaling.
- Identify weaknesses of a project to strengthen the project and/or identify points of attention for future (NbS) projects.

The sharing of the results of assessments with the IUCN Standard and the challenges faced in application can be beneficial for several reasons. To begin with, it is suggested that practitioners share the assessment results and challenges in application with the IUCN, such that these can be accounted for in the four-year periodic updates of the IUCN Standard. Furthermore, it is recommended that practitioners share the results with other practitioners of the standard, as the comparison of assessments of different projects may provide learning opportunities to strengthen the assessed and future (NbS) projects. In particular, the radar chart, which is an output of the self-assessment tool, can be a valuable tool for the comparison of projects. The chart presents the identified strenghts and weaknesses of the project in a

visually clear manner and has the potential to provide insights into the project characteristics that drive these strengths and weaknesses. In order to facilitate the sharing of applications and lessons learnt, it is suggested that the IUCN sets up a user group for practitioners. The governance structure of the IUCN Standard includes such a user group, however, this group is not yet functional (IUCN, 2020a).

Based on the conclusions concerning data collection, consultation of project experts (i.e., people that have been closely involved for a significant part of the project duration) is strongly recommended for a successful ex-post evaluation of a project with the IUCN Standard. Furthermore, even though these were not identified as essential elements for a succesfull evaluation, it is suggested to (i) conduct interviews with directly affected stakeholders for a more substantiated and accurate evaluation, and (ii) visit the project location to increase the ease of data collection. As the IUCN Standard functions as a suitable tool for the evaluation of project processes, but falls short in evaluating the results of a project, it is recommended that the IUCN Standard is used in combination with a results-oriented framework, such that the effectiveness of the project is also evaluated. This evaluation should not be limited to the biophysical effects, but incorporate the full social ecological system.

In addition to the above recommendations, the following suggestions with regard to the self-assessment tool follow from the discussion in section 6.1. If a project adheres to the IUCN Standard, it is suggested that users frame this result as "being in adherence to the IUCN Standard", rather than "qualifying as a NbS", and that users always include the degree of adherence (*partial, adequate or strong*). Furthermore, in order to further optimize the self-assessment tool, it is suggested that the IUCN includes (i) an additional criterion for the evaluation of targets, benchmarks and monitoring for the societal challenge(s) that the project aims to address (e.g., flood risk) and (ii) an option for a "neutral" score for indicator 5.5.

Even though the scope of the research was ex-post application of the IUCN Standard and therefore no statements can be made on the applicability of the standard when used in the design or implementation phase, a number of suggestions can be provided based on the literature study. To begin with, the self-assessment tool of the IUCN Standard is also suitable for evaluation of a project when the design phase is complete (i.e., ex-ante) or during the implementation phase (i.e., operational). It is suggested to use the IUCN Standard in this way to identify weak points of a project for improvement, although it can also be used for most of the other purposes listed for its ex-post application. Furthermore, the IUCN Standard can be used to guide purposeful design of a NbS project. If used for design purposes, practitioners should consider using the user-friendly framework (IUCN, 2020a) and in-depth guidance (IUCN, 2020b), which provide elaborate guidance on how to develop a project that adheres to the criteria and indicators of the IUCN Standard, such as a list of the minimum information that should be included in a baseline assessment. These documents are also suitable for comparison with existing designing and planning approaches for their optimization. Interest in this application of the IUCN Standard was shown by a project expert of the Missouri River Levee Setback Project, as stated in section 5.4.3.

Lastly, in mainstreaming of the NbS concept within FRM (i.e., ensuring that NbS is always part of a full set of solutions for FRM problems), policy makers should consider the IUCN Standard as a tool to evaluate the extent to which a set of solutions includes NbS. In this ex-ante application, the IUCN Standard can provide a percentage match to which the processes within a set of solutions is in line with the standard of practice of NbS projects, as established by the IUCN.

### 7.2.2 Recommendations for future research

As suggested in the previous section, application of the IUCN Standard in combination with a results-oriented framework would allow for the evaluation of both the processes and results of a project. To better understand how the IUCN Standard can effectively be used in combination with a results-oriented framework, it is recommended that future studies research the application of the IUCN Standard together with a suitable results-oriented framework on case studies. In addition, research on the differences between application of the IUCN Standard and (i) a results-oriented framework, such as the framework by Andrikopoulou (2020), or (ii) another process-oriented framework, such as the framework by Huthoff et al. (2018), may provide more detailed insights into the shortcomings and benefits of the standard.

In order to further validate the IUCN Standard as a common and global framework that is applicable to all types of NbS, further research is needed on its applicability in other sectors (e.g., urban and coastal) and countries (e.g., developing countries). Out of the three case studies, the highest percentage match to the IUCN Standard is achieved by the Eddleston Water Project (*sixty-five percent*), which a project expert considers to be relatively low, since the processes of this project are generally well-developed. For a better understanding of the implications of the total percentage match, more applications of the IUCN Standard to well-founded NbS projects are recommended. These would allow to identify whether the IUCN Standard is a realistic standard of practice for NbS or an aspirational standard. Furthermore, applications of the IUCN Standard to projects that have excellent processes, but do not comply to any of the definitions of NbS are recommended to identify whether these projects can meet the requirement of a twenty-five percent match to each of the criteria to be in adherence to the standard. This would provide a better understanding of the implications of being in adherence to the IUCN Standard.

For a better understanding of the accuracy and reproducibility of the results of an assessment with the IUCN Standard, it is recommended that a separate research is conducted in which a sufficiently large group of individuals applies the standard to the same case study, where the differences in the results will be an indication of their accuracy and reproducibility. An interesting addition to this research would be to conduct sensitivity analyses on the influence of (i) the amount of instructions about the self-assessment procedure and (ii) the way in which data is collected or provided, on the accuracy and reproducibility of the results. Such a sensitivity analysis can potentially be conducted by providing half of the group with a complete overview of the required data and letting the other half of the group collect data themselves through publicly accessible documentation (and interviews). Furthermore, in order to complete and validate the list of ways in which application of the IUCN Standard may provide added value, given in section 5.5.1, future studies should conduct interviews with various individuals and organizations on their thoughts about the added value of the results. Lastly, following up on the suggestion that policy makers should consider the IUCN Standard as a tool in the mainstreaming of NbS, covered in section 7.2.1, further research is required to analyse the possibilities of incorporating the standard into policies that determine whether NbS is sufficiently part of a set of solutions for FRM.

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# Appendix A - Flexibility of assessment frameworks

In section 3.1, an inventory of twenty-two assessment frameworks for NbS is established, in which the individual frameworks are indicated with framework numbers. The frameworks differ with regard to the amount of flexibility in assessment of a project that is provided to the user of the framework. A detailed overview of the flexibility of each of the frameworks is provided in Table A.1, where the arrow indicates the direction of an increase in the flexibility provided by the framework. Together with the data listed in Table 3.2, the flexibility of the frameworks provide the data for the development of the graphical representation of the inventory of frameworks that is provided in Figure 3.2.

*Table A.1 – Flexibility provided by the frameworks in the inventory of assessment frameworks for NbS.*

| **Flexibility of framework - The framework provides…** | **Framework number** |
|---|---|
| A methodology for stakeholder meetings and workshops for the identification of the elements to be assessed and the valuation of these elements. | 4, 9, 16 |
| Guidance on the selection of indicators with no or very limited (1 – 2) examples of indicators. | 3, 5, 13, 19 |
| Guidance on the selection of indicators with limited references to other frameworks and/or publications for examples of indicators. | 15 |
| Guidance on the selection of indicators with elaborate explanation of examples of indicators that are included in other frameworks. | 8.2, 20 |
| A list of examples of indicators, while indicators of other sources may be included as well. | 2, 6, 17 |
| A fixed list of indicators with the option for tailoring (i.e., leaving out irrelevant indicators). | 7, 10, 12 |
| A fixed list of indicators with the option for tailoring and makes a distinction between recommended and additional indicators. | 8.1 |
| A fixed list of (i) criteria, without the option for tailoring, and (ii) indicators, with the option for tailoring. | 1 |
| A fixed list of indicators, without the option for tailoring. | 11, 14, 18, 21 |

# Appendix B - Indicators and guidance of IUCN Standard

The indicators and accompanied guidance, composed of guiding questions and concise answers for the scoring options, are provided for each of the eight criteria of the IUCN Standard in Table B.1 to B.8. The content and lay-out of the tables follow directly from the self-assessment tool of the IUCN Standard.

*Table B.1 – Indicators and accompanied guidance for Criterion 1: "NbS effectively address societal challenges".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **1.1** | The most pressing societal challenges for rights holders and beneficiaries are prioritised | Are societal challenges identified? Are rights holders and beneficiaries consulted? Are the most pressing societal challenges for rights holders and beneficiaries prioritised? | Yes. The most pressing societal challenges prioritized based on full consultation with rights holders and beneficiaries. | Specific societal challenges identified with some consultation with rights holders and beneficiaries. | General societal challenges identified with limited input from some rights holders and beneficiaries only. | No. No clear societal challenges identified and/or no consultation with any rights holders and beneficiaries. |
| **1.2** | The societal challenges addressed are clearly understood and documented | Are the drivers and responses to the societal challenges identified? Are the societal challenges understood at the relevant national/local context? Are the societal challenges documented and accessible to affected stakeholders? | Yes. The drivers of and responses to identified societal challenges are well understood, including with reference to the relevant national/local context, and are fully documented and accessible. | Drivers of and responses to identified societal challenges are broadly understood within the relevant context although some documentation and knowledge gaps persist. | Societal challenges framed in terms consistent with widely accepted narratives but multiple documentation and context-specific knowledge gaps persist. | No. Superficial/limited understanding of drivers of and responses to identified societal challenges with limited or no documentation. |
| **1.3** | Human wellbeing outcomes arising from the NbS are identified, benchmarked and periodically assessed | Are human wellbeing outcomes relevant to the identified societal challenges identified? Are there benchmarks in place to monitor impact? Are outcomes and benchmarks assessed at regularly occurring intervals? Are human wellbeing outcomes incorporated into the strategy for the intervention? | Yes. SMART human well-being outcomes and benchmarks, relevant to the identified societal challenges and national/local context, are identified and are assessed at regularly occurring intervals. | Specific human well-being outcomes and benchmarks, relevant to the identified societal challenges and national/local context, are identified and assessed at least once during the intervention period. | General human well-being outcomes and benchmarks identified but no provision has been made for their assessment. | No. Human well-being outcomes are not identified or are vague and ill defined with no benchmarks and no provision for assessment. |

*Table B.2 – Indicators and accompanied guidance for Criterion 2: "Design of NbS is informed by scale".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **2.1** | Design of NbS recognises and responds to the interactions between the economy, society and ecosystems | Are interactions identified between the economy, society and ecosystems? Does that include those within and surrounding the intervention area? Is the change in these interactions considered over time? Are potential knock-on impacts on and from other areas identified? Are these interactions used to design the intervention and decision making processes? | Yes. The design of the NbS considers in detail the interactions between the economy, society and ecosystems within and surrounding the intervention area, given its potential knock-on impacts on and from other areas/sectors. These interactions are accounted for in the decision-making process throughout the intervention timescale. | The design of NbS recognises specific interactions between the economy, society and ecosystems, and these are accounted for in the NbS decision-making processes, at least once during the intervention period. | The design of NbS recognises and responds to some of interactions between the economy, society and ecosystems although knowledge gaps remain. These are partially or not at all accounted for in decision-making processes. | No. The design of the NbS does not recognise nor respond to the interactions between the economy, society and ecosystems. |
| **2.2** | Design of NbS integrated with other complementary interventions and seeks synergies across sectors | Are complementary interventions identified in and around the area? Is the design of the NbS integrated with relevant complementary interventions? Are synergies sought in project management, monitoring and outcomes? Are complementary interventions and synergies re-assessed throughout the intervention time scale? | Yes. Synergies across sectors are thoroughly investigated, and all relevant complementary interventions are integrated within the design of the NbS. These are investigated and revisited at relevant points throughout the intervention time scale. | Synergies across sectors are investigated and the most relevant complementary interventions are integrated within the design of the NbS. These are revisited at least once during the intervention period. | Synergies across some sectors are broadly identified, but knowledge gaps persist and only some complementary interventions are integrated into the design of the NbS. | No. Synergies across sectors are not identified, and if any complementary interventions are identified, they are not integrated into the design of the NbS. |
| **2.3** | Design of NbS incorporates risk identification and risk management beyond the intervention site | Have the drivers of internal and external risks been identified? Has scientific and local knowledge concerning those risks been taken into account? Does the design of the NbS take into account possible internal and external risks? Has a risk management plan been integrated into the design of the NbS? Will this risk management plan be revisited throughout the intervention time scale? | Yes. The possible risks of undesirable changes and their drivers are identified, taking into account scientific and local knowledge. The management of these risks is integrated into the design of the NbS and revisited throughout the intervention time scale. | Most risks of undesirable changes and their drivers are identified, taking into account scientific and local knowledge. The management of most of these risks is integrated into the design of the NbS and revisited at least once during the intervention time scale. | Some possible risks are identified and taken into account in the design of the NbS, but context-specific knowledge gaps persist and multiple documentation (e.g. their management, within the intervention site and across the broader land/seascape) are lacking. | No. Limited or no risks are identified and, where identified, the management of these are not integrated into the design of the NbS. |

*Table B.3 – Indicators and accompanied guidance for Criterion 3: "NbS result in a net gain to biodiversity and ecosystem integrity".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **3.1** | NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss | Is the current state of relevant ecosystems assessed? Is this assessment at the appropriate spatial and temporal scale? Are the drivers of ecosystem degradation and biodiversity loss assessed? Does the assessment include field verification? Does the assessment take into account scientific and local knowledge? Do NbS actions respond to the assessment and identified drivers of degradation and loss? | Yes. An updated assessment of the current status of ecosystems at the appropriate spatial and temporal scales is in place. The assessment includes information about the drivers of change and biodiversity loss. The assessment includes field verification and local knowledge. | There is information available about the current state of the ecosystems using secondary data and reference maps, not older than 10 years. The information of the ecosystem has been verified in general terms through field visits, with general inputs from local communities and traditional knowledge, where possible. | General information about existing land cover and land use is used for assessing the status of the ecosystems, at more general scales and not older than ten years. There is not validation at field level and data coming from communities or traditional knowledge. | No. There is no information available about general conditions of the status of the ecosystems at any relevant spatial or temporal scale. |
| **3.2** | Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed | Are clear and measurable biodiversity conservation outcomes identified? Are these outcomes based on an understanding of the current ecosystem state? Are these outcomes applicable to the relevant period of time for the intervention? Are benchmarks for desired change in place? Are the conservation outcomes periodically assessed? | Yes. The NbS objectives include: specific and measurable indicator variables related to biodiversity and ecosystem integrity, the direction of desired change (increase, decrease, maintain), the magnitude of desired change (e.g., 80%) and the timeframe (e.g., within 5 years). Prior to initiating treatments, a monitoring and evaluation system is in place that includes the variables to be assessed, the frequency of assessment, the analyses that will be done to determine outcomes, and how information will be shared. Also prior to initiating treatment, a baseline assessment of the indicator variables has been conducted. –Depending on the conservation actions proposed, monitoring and assessment yields enough information to indicate species or ecosystem recovery or a measurable extent of recovered areas, over a relevant period of time. | The NbS outcomes include measurable indicator variables related to biodiversity and ecosystem integrity, but may lack specific details related to the magnitude of desired change (e.g., 80%) and the timeframe (e.g., within 5 years). Prior to initiating treatments, a baseline assessment has been conducted and a monitoring and evaluation system is in place, but may lack detail on the frequency of assessment, the analyses that will be done to determine outcomes, or how information will be shared. There is not enough information on ecosystem indicators for a relevant period of time. | The NbS outcomes related to biodiversity and ecosystem integrity lack specificity. There is a general indication about relevant conservation outcomes and a monitoring system is under preparation. | No. The NbS lacks identified outcomes related to biodiversity or ecosystem integrity. There is no monitoring system in place and no data about ecosystem or species recovery. |
| **3.3** | Monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS | Is a monitoring and assessment plan in place for ecosystems, species and ecological processes? Is the monitoring plan based around measurable variables related to potential adverse impacts on nature arising from the NbS, both direct and indirect? Are actions in response to those impacts in place? Is the monitoring plan properly implemented with measurements taking place at periodic intervals? | Yes. Possible adverse impacts of NbS interventions on ecosystems, ecological process and species identified and actions to mitigate those impacts are mobilized. Specific measurable variables related to potential adverse impacts have been included in the baseline assessment, a monitoring and evaluation system of these impacts is properly implemented, and actions to address those impacts are in place. | The NbS plan has identified possible adverse impacts of NbS interventions on ecosystems, ecological process and species, and has included actions to mitigate those impacts, however lack of clarity on how actions will be mobilised and resourced. A monitoring plan for assessing adverse impacts is under development, including actions to counteract the effects of those impacts. | There is a general identification of possible impacts of NbS actions at ecosystem level and plans to mitigate those impacts are in place. | No. There is no identification of potential impacts of NbS interventions and these impacts are not assessed. |
| **3.4** | Opportunities to enhance ecosystem integrity and connectivity identified and incorporated into the NbS strategy | Are the requirements to maintain or recover ecosystem integrity identified? Are opportunities to enhance ecosystem connectivity and integrity assessed? Are actions in response to these requirements and opportunities incorporated into the NbS strategy? | Yes. There is a detailed assessment of requirements to maintain or recover ecosystem integrity. Options to enhance the integrity of the ecosystem or connectivity, where appropriate, are identified and implemented. These options might include soil recovery practices, ecological restoration activities, isolation practices, or conservation actions for targeted species. | There is a general identification of potential options to enhance ecosystem integrity or connectivity, where appropriate, and a plan to incorporate them into the NbS strategy. | There is a general identification of potential actions to enhance ecosystem integrity or connectivity, where appropriate. | No. There is no identification of any options to enhance ecosystem integrity or connectivity. |

*Table B.4 – Indicators and accompanied guidance for Criterion 4: "NbS are economically viable".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| 4.1 | The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented | Are the direct and indirect benefits and costs associated with the NbS and who receives them identified? Is this fully documented? Is this verified with key informants? Can "winners" and "losers" be easily ascertained? | Yes. All the main direct and indirect costs and benefits have been established, verified with key informants and are fully documented. The distribution of the costs and benefits are well understood and "winners" and "losers" can be easily ascertained. | Analysis of costs and benefits includes both financial and non-financial elements and a clear description of indirect costs and benefits, although some gaps in understanding are still evident. There is a good understanding of how costs and benefits are distributed but limited verification with key informants. | Analysis of costs and benefits include both financial and non-financial elements although significant gaps in understanding with respect to indirect costs and benefits. There is a general understanding of how the major costs and benefits are distributed but it is not comprehensive and lacks verification. | No. Identification of costs and benefits is limited only to the immediate and direct financial transactions of the initiative. Understanding of how costs and benefits are distributed is superficial and/or anecdotal |
| 4.2 | A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies | Is cost-effectiveness analysed? Does the study include upfront and recurring direct and indirect costs as well as the full flow of benefits overtime? Are the key assumptions of cost-effectiveness identified? Does the study include measuring the impact of any relevant regulations and subsidies? Does the study support the choice of actions for the intervention? Is a sensitivity analysis conducted against critical variables? | Yes. A full cost effectiveness study has been conducted according to best practice and includes upfront and recurring direct and indirect costs, the full flow of benefits overtime and key assumptions. Sensitivity analysis has been conducted against critical variables (including changes to key regulatory and subsidy arrangements), the long-term economic and financial sustainability is well understood as well as the economic risks. | A cost effectiveness study is available which includes upfront and recurring direct and indirect costs and the flow of key benefits. Key assumptions have been identified but a full sensitivity analysis has not been undertaken. The long-term economic and financial sustainability is broadly understood but there may be gaps in the framing of future economic risks with respect to changes in regulation and subsidy regimes. | A basic internal rate of return has been calculated drawing primarily on direct upfront and recurring costs and direct benefits. However there are significant gaps in accounting for indirect costs and benefits and key assumptions have not been tested. There is a limited understanding of the impacts of changes to current regulations and subsidy regimes. | No. There has been no attempt to calculate or estimate even a basic internal rate of return or otherwise understand how the flow of benefits over time compare against upfront and recurring costs. |
| 4.3 | The effectiveness of an NbS design is justified against available alternative solutions, taking into account any associated externalities | Are available alternative solutions identified? Is the intervention design's effectiveness justified against available alternative solutions? Is this justification documented? Are associated externalities adequately taken into account? | Yes. The effectiveness and affordability of the intervention against the next best alternative(s) are fully economically justified, understood and documented. | The effectiveness and affordability of the intervention can be broadly justified although gaps in the analysis, particularly with respect to a comprehensive understanding of the alternate's cost, benefits and risks, persists. | Viable alternate solutions have been identified and their pros and cons have been documented but only limited and basic economic analysis has been conducted. | No. There has been no meaningful review of the proposed intervention's cost effectiveness against other viable alternatives |
| 4.4 | NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance | Is there a comprehensive review of resourcing options? Does this review cover the costs of delivery of the intervention's primary and ancillary benefits? Has a full resourcing package been assembled and negotiated? Does this resourcing package include provision for future revenue streams? | Yes. A comprehensive review of resourcing options that covers the costs of delivery of the intervention's primary and ancillary benefits has been undertaken and a full resourcing package has been assembled and negotiated, including provision for future revenue streams. | The principle source of long-term funding is identified and secured. Potential viable sources of complementary resourcing have been identified and thoroughly assessed, including accompanying legal, regulatory and contractual obligations. While a comprehensive resourcing package has been identified it has not yet been negotiated | The principle source of long-term funding is identified and secured. Potential viable sources of complementary resourcing have been identified although more analysis is required to properly assess feasibility. | No. There is no clear understanding (or guarantee) of even the main long-term funding source beyond that required to cover the costs of immediate start-up or piloting phase. There has been no analysis of potential future revenue streams and no preliminary analysis of complementary resourcing options. |

*Table B.5 – Indicators and accompanied guidance for Criterion 5: "NbS are based on inclusive, transparent and empowering governance processes".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| 5.1 | A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention can be initiated | Is there a legitimate feedback and grievance mechanism? Are affected stakeholders consulted for the development of this mechanism? Is this mechanism documented, predictable and transparent? Is this mechanism available and accessible to all stakeholders? Is the mechanism available to stakeholders from before the start of the intervention? Is the mechanism right-compatible? Is the ownership and trust of the mechanism evident? Is the mechanism regularly reviewed and adapted? | Yes. A feedback and grievance resolution mechanism is developed in full consultation with affected stakeholders. The mechanism is legitimate, accessible, predictable, equitable, transparent, rights-compatible, and adaptively managed. There is clear evidence of ownership and trust in the mechanism | A feedback and grievance resolution mechanism is developed in full consultation with affected stakeholders. The mechanism is legitimate, accessible, predictable, equitable, transparent, rights-compatible, and adaptively managed. Ownership and trust in the mechanism is likely but currently cannot be substantiated | A feedback and grievance resolution mechanism is developed with limited input from some affected stakeholders. The mechanism is not fully legitimate, accessible, predictable, equitable, transparent, rights-compatible or adaptively managed. | No. A feedback and grievance resolution mechanism is not or only partially developed with no consultation with affected stakeholders. |
| 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) | Are indigenous peoples impacted, either directly or indirectly, at any point during the intervention? Does the intervention uphold the right of Indigenous Peoples to Free Prior and Informed Consent throughout the intervention timescale? Is participation based on mutual respect and equality? Are there processes in place to support this throughout the intervention timescale? | Yes. FPIC was obtained through high level participation from representative institutions and processes have been established to ensure this is upheld throughout the NbS timescale. | High level participation was achieved from most representative institutions. Processes have been established to ensure this is upheld throughout the intervention with priority stakeholders although gaps persist with some stakeholders. | Information giving and consultation was provided early in the NbS process with some representative institutions. No processes in place to ensure this persists throughout the intervention. | No. FPIC has not been obtained and processes have not been established to ensure this is upheld. |
| 5.3 | Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention | Are the stakeholders who are directly and indirectly affected by the NbS identified? Is their impact and interest in the intervention mapped? Are they involved in all processes of the intervention? Do affected stakeholder accept and feel ownership over the outcomes of the intervention? | Yes. A robust multi-scale multi-sector stakeholder analysis was conducted to identify who may be directly and indirectly affected by the NbS. Affected stakeholders were involved in all processes from the start of the intervention and accept/own the outcomes | A stakeholder analysis was conducted identifying stakeholders who may be directly or indirectly affected by the NbS. Most stakeholders were then involved in the processes of the intervention although some gaps remain. Ownership cannot be substantiated | Limited stakeholder analysis was conducted identifying only some of the stakeholder who may be directly or indirectly affected by the NbS. Of those identified, some have been engaged in the processes of the NbS. | No. No stakeholder analysis has been conducted to identify who maybe directly and indirectly affected by the NbS. |
| 5.4 | Decision-making processes document and respond to rights and interests of all participating and affected stakeholders | Are decision-making processes being documented? Is this documentation transparent and accessible? Do they respond to the rights and interests of all participating and affected stakeholders? Is specific attention paid to stakeholders subject to extreme inequity? | Yes. Decision-making processes take into account the rights and interests of all participating and affected stakeholders, with specific attention paid to stakeholders subject to extreme inequity. The procedures are documented and this documentation is transparent and accessible. | Decision-making processes take into account the rights and interests of all participating and affected stakeholders. The procedures are documented and this documentation is transparent and accessible. | Decision-making processes map rights and interests of all or some participating and affected stakeholders. The procedures are documented however no clear plan to take into account stakeholder decisions. Gaps remain and/or there is a lack of transparency or accessibility. | No. Decision making processes do not take into account rights and interests of stakeholders and/or are not documented. |
| 5.5 | Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making among the stakeholders in those jurisdictions affected by the NbS | Do ecological processes and functions of the ecosystems in the intervention extend beyond jurisdictional boundaries? If so, is joint decision-making being enabled among the stakeholders affected by the NbS in all jurisdictions? Are transboundary cooperation's agreements created between affected stakeholders in all jurisdictions? | Yes. Whether and where the NbS intervention area extends beyond jurisdictional boundaries is identified. Where this is the case, transboundary cooperation's agreements are created between affected stakeholders in all jurisdictions. Joint decision-making is enabled. | General understanding whether the NbS intervention area extends beyond jurisdictional boundaries. Some transboundary cooperation's agreements are created between affected stakeholders in jurisdictions although gaps persist. | Limited identification of whether and where NbS intervention area extends beyond jurisdictional boundaries. There is a lack of transboundary cooperation agreements. | No. Not know whether or where NbS intervention area extends beyond jurisdictional boundaries. |

*Table B.6 – Indicators and accompanied guidance for Criterion 6: "NbS equitably balances trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **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 | Are costs and benefits both at the NbS site and the larger landscape/seascape, throughout the NbS intervention time-scale identified? Are the potential NbS costs and benefits of associated trade-offs explicitly acknowledged? Are they used to inform safeguards? Are they used to inform corrective actions if those safeguards are passed? Is the process of decision-making regarding costs and benefits disclosed to affected stakeholders? | Yes. The cost benefits analysis considers costs and benefits both at the NbS site and the larger landscape/seascape, throughout the NbS intervention time-scale. Costs and benefits are used to inform safeguards and corrective actions. Process of decision-making on choices is disclosed to all stakeholders | The cost benefit analysis considers most spatial and temporal dimensions. Costs and benefits identified are used to inform safeguards and corrective actions although there are some gaps. | A limited cost benefit analysis is carried out only considering the NbS site and/or only for specific parts of the NbS lifecycle. Costs and benefits identified have not been used to inform safeguards and corrective actions. | No. No cost benefit analysis of trade-offs is carried out and/or no safeguards or corrective actions are in place. |
| **6.2** | The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected | Are the rights, usage of and access to land and resources as well as stakeholder responsibilities identified? Are they incorporated into a stakeholder mapping analysis? Are they acknowledged and respected? Do they inform the design of the intervention? | Yes. All the rights, usage of and access to land and resources, as well as stakeholder responsibilities are analysed using a stakeholder mapping/analysis. Rights, usage of and access to land and resources are respected and inform the design of NbS. | Most rights, usage of and access to land and resources, as well as responsibilities were analysed using a stakeholder mapping/analysis. All those analysed are acknowledged and respected although knowledge gaps persist in some areas or parts of the NbS. | Some rights, usage of and access to land and resources, as well as responsibilities are analysed. However this was not done using appropriate tools and not linked to the outcomes of stakeholder analysis or mapping with only few stakeholders considered. Only some of those analysed are acknowledged and respected. | No. The rights, usage of and access to land and resources, as well as responsibilities are not identified. |
| **6.3** | Established safeguards are periodically reviewed to ensure that mutually-agreed trade-offs limits are respected and do not destabilise the entire NbS | Are there mutually agreed upon limits of trade-offs and are they being respected? Are there established safeguards in place to prevent these being exceeded or to prevent trade-offs destabilising the entire ecosystem or land/seascape? Are these safeguards being periodically reviewed? Is clear documentation of safeguards and their review provided? | Yes. Mutually agreed upon limits of trade-offs are in place, documented, and respected. Safeguards are in place and are periodically reviewed throughout the intervention time scale, with clear documentation of this being provided. | Mutually agreed upon limits of some trade-offs are in place and are respected. Safeguards are in place and are occasionally reviewed, with documentation provided | Mutually agreed upon limits of only a few trade-offs are in place and/or are not being respected. Few safeguards are in place but are sporadically reviewed. There is no documentation of the process | No. Mutually agreed upon limits of trade-offs have not been considered and no safeguards have therefore been put in place. |

*Table B.7 – Indicators and accompanied guidance for Criterion 7: "NbS are managed adaptively, based on evidence".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **7.1** | A NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention | Is there a strategy for the intervention for how societal challenges will be addressed? Does the strategy precisely state intended outcomes, actions and assumptions in regards to economic, social and ecological conditions? Does the strategy elaborate on whether and how assumptions may change? Is it consistently being used as a basis for regular monitoring and evaluation of the intervention? | Yes. A strategy is established that precisely states intended outcomes, actions and assumptions made in regards to economic, social and ecological conditions. The strategy elaborates on whether/how assumptions may change and is consistently used a basis for monitoring and evaluation of the intervention occurring at regular intervals. | A strategy is established that states intended outcomes, actions and assumptions relevant to the current context. The strategy is used to inform monitoring and evaluation of the intervention in the design and implementation stage. | A strategy is established that states some intended outcomes, actions and assumptions. The strategy does not inform the monitoring and evaluation of the intervention and/or does not take into account changing assumptions. | No. Incomplete or no strategy established, with no link to economic, social and ecological conditions and little link to monitoring and evaluation of the intervention. |
| **7.2** | A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle | Is there a robust monitoring and evaluation plan in place? Is it being implemented throughout the lifecycle of the intervention? Does this plan include how deviations of the strategy trigger an adaptive management response? | Yes. A robust and adaptive monitoring and evaluation plan is in place to be implemented at regular intervals throughout the intervention lifecycle. The plan includes how deviations from the strategy trigger an adaptive management response. | A monitoring and evaluation plan is in place to be implemented throughout the intervention lifecycle albeit not at a regular basis. A clear process for how deviations will trigger an adaptive management response is lacking. | A monitoring and evaluation plan is in place to be implemented throughout the intervention lifecycle albeit not at a regular basis. A clear process for how deviations will trigger an adaptive management response is lacking. | No. Incomplete or no monitoring and evaluation plan in place. No link to how the plan could trigger an adaptive management response. |
| **7.3** | A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle | Is there a plan to learn and adapt in response to the monitoring and evaluation plan? Is there a learning framework applied to the NbS for iterative learning throughout the intervention lifecycle? Does this enable adaptive management? Is there are strategy for how learning persists beyond the time frame of the intervention? | Yes. There is a learning framework that is applied throughout the intervention lifecycle and that is used continuously to learn and adapt in response to results of the monitoring and evaluation plan. Strategy in place for how learning would persist beyond time frame of intervention. | There is a learning framework that is applied at different stages of the intervention lifecycle. It is linked to the monitoring and evaluation plan. | Incomplete learning framework lacking clarity on how monitoring and evaluation will lead to learning and adaptation. | No. Incomplete or no learning framework. No to the monitoring and evaluation of the intervention. |

*Table B.8 – Indicators and accompanied guidance for Criterion 8: "NbS are sustainable and mainstreamed within an appropriate jurisdictional context".*

| Indicator No. | Indicator | Guiding questions | How well has the indicator been met? | | | |
|---|---|---|---|---|---|---|
| | | | Strong | Adequate | Partial | Insufficient |
| **8.1** | NbS design, implementation and lessons learnt are shared for triggering transformative change | Are NbS design, implementation and lessons learnt being systematically captured? Are they being shared both on demand and with strategic audiences? Is this sharing accessible to target audiences? Is a communication strategy in place? Does this strategy detail how communication will change behaviours and how this will trigger transformational change? | Yes. NbS lessons learnt have been systematically captured and subsequently shared both upon demand and with strategic audiences in an accessible manner. A communication strategy is in place identifying how this change behaviours to trigger transformational change. | Lessons learnt have been systematically captured and some sharing both upon demand and with relevant audiences in an accessible manner. Communications strategy is incomplete. | Provision made to systematically capture lessons learnt. Some lessons learnt are shared with relevant audiences. There are barriers to accessibility (time frame, language, visibility, etc.) whether on demand or freely available. No communications strategy in place. | No. Lessons learnt are not captured and/or shared. Not communications strategy in place. |
| **8.2** | NbS inform and enhance facilitating policy and regulation frameworks to support its uptake and mainstreaming | Are policy, regulations and laws relevant to the intervention being identified? Are their impacts and opportunities being mapped? Are early adopters and entry points being identified? Are the interventions actions and communications informing or enhancing facilitating policy and regulation frameworks? Is this supporting uptake and mainstreaming of NbS? | Yes. NbS actions incorporate a review of policy, regulations and laws that are relevant to the NbS, that can be used to support their uptake and mainstreaming. Where necessary and possible, the NbS may inform and enhance policy and regulating frameworks amendment, to ensure sustainability. | The policy, laws and regulations relevant to the NbS were identified and taken into account as part of the design of the NbS, and their potential use to support NbS or necessary amendment, were partially included. | Some relevant policy, regulations or laws were identified as part of the design of the NbS, but knowledge gaps (*e.g.* their potential use to influence the NbS, their relevance to the NbS, possible amendment) remain and no link to them was thought of or planned. | No. The NbS design and operational plans have not been framed within the context of prevailing land-use and other relevant policies, regulations or laws and has not engage with other key stakeholders on issues that related to enabling policy, legal and regulatory frameworks. |
| **8.3** | Where relevant, NbS contribute to national and global targets for human wellbeing, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) | Are relevant national and global targets for human wellbeing, climate change, and biodiversity and human rights being identified? Does this include UNDRIP? Are the interventions actions contributing to any of these targets? Is this contribution being reported in relevant platforms? IS this facilitating mainstreaming and upscaling of the intervention? | Yes. Relevant national and global targets for human wellbeing, climate change and biodiversity have been identified. The potential contribution of the NbS to these targets was identified is reported in the relevant platforms, to facilitate mainstreaming and upscaling of the NbS intervention. | Relevant national and global targets for human wellbeing, climate change and biodiversity have been identified. The potential contribution of the NbS to these targets was partially identified and partially reported in the relevant platforms. | Some national and global targets for human wellbeing, climate change and biodiversity have been identified as part of the NbS design. But the potential contribution of the NbS to these targets was only partially identified and not reported in the relevant platforms. | No. No relevant national and global targets for human wellbeing, climate change and biodiversity have been identified. The potential contribution of the NbS to these targets was not identified and nor reported in the relevant platforms. |

# Appendix C - Calculation of features of case studies

This appendix covers the calculation of the surface area covered by the measures implemented in the Eddleston Water Project (*Appendix C.1*) and the flow velocity of the rivers at the location of each of the three case studies, used to represent their respective kinetic energies (*Appendix C.2*).

## C.1 Surface area of measures implemented in the Eddleston Water Project

The surface area covered by the NbS measures implemented in the Eddleston Water Project is estimated to be 2.13 $km^2$, based on a rough estimation provided in Table C.1.

*Table C.1 – Estimation of the surface area of NbS measures implemented in the Eddleston Water Project.*

| NbS measure | Calculation | Surface area |
|---|---|---|
| Tree planting | = 207 ha (Spray, 2022a, p. 15) | 2.07 $km^2$ |
| Engineered log jams | Additional storage by 1 log jam = 100 $m^3$ / 32 = 3.13 $m^3$ (*based on data for 1/25 year event by Spray (2017, p. 37))*<br><br>Surface area covered by 1 log jam = 3.13 $m^3$ / 1 m = 3.13 $m^2$ *(based on approximation of water elevation behind a log jam by Spray (2017, p. 37))*<br><br>Surface area covered by log jams = 116 log jams (Spray, 2022a, p. 15) * 3.13 = 363.0 $m^2$ | 3.63 * $10^{-4}$ $km^2$ |
| Re-meandering | Surface area covered by 1 km of re-meandering = 3000 $m^2$ / 2.2 = 1363.64 $m^2$ = 1.36 * $10^{-3}$ $km^2$ (Spray, 2017, p. 17)<br><br>Surface area covered by re-meandering = 3.5 km (Spray, 2022a, p. 15) * 1.36 * $10^{-3}$ = 4.77 * $10^{-3}$ $km^2$ | 4.77 * $10^{-3}$ $km^2$ |
| Storage ponds | = 38 ponds (Spray, 2022a, p. 15) * 1340 $m^2$ (Gyger, 2022, p. 13) = 5.09 * $10^4$ $m^2$ | 5.09 * $10^{-2}$ $km^2$ |
| **Total surface area** | | **2.13 $km^2$** |

## C.2 Kinetic energy of rivers at the case studies

As stated in section 4.1, the respective kinetic energy per unit volume of rivers can be represented by the flow velocities. In order to identify whether the relative kinetic energy of the river at each of the case studies is low or high, the flow velocities are calculated at the following locations of the rivers:

**Case study 1 - Eddleston Water Project:** Eddleston Water at Darnhall, Scotland.
**Case study 2 - RfR Deventer project:** IJssel at Olst, Netherlands.
**Case study 3 - Missouri River Levee Setback Project:** Missouri River at Nebraska City, USA.

As a rough estimate of the flow velocity is sufficient to demonstrate the relative difference in kinetic energy, the differences in flow velocity throughout the year are not taken into account. At 10.00am on the 2nd of November 2022, all three rivers were in recession with a discharge that is close to the typical discharge of the river (Rijkswaterstaat, 2022; SNOFLO, 2022; University of Dundee, 2022). Therefore, the real-time flow velocity at this moment is used for the comparison of the relative kinetic energy of the rivers. The corresponding calculation with equation C.1 is provided in Table C.2.

$$v = \frac{Q}{A} = \frac{Q}{w * h} \quad (C.1)$$

Where:
- v = flow velocity of river [m/s]
- Q = discharge of river [$m^3/s$]
- A = cross-sectional area of river [$m^2$]
- w = width of river [m]
- h = water level [m]

*Table C.2 - Estimation of the respective kinetic energy per unit volume of the rivers at the three case studies.*

| **Case study** | **Discharge [$m^3/s$]** | **Width [m]** | **Water level [m]** | **Flow velocity [m/s]** | **Respective Kinetic Energy** |
|---|---|---|---|---|---|
| Eddleston Water Project | 0.89 (A. Black, personal communication, November 2, 2022) | 5.95 (A. Black, personal communication, November 2, 2022) | 0.2 (A. Black, personal communication, November 2, 2022) | 0.70 | **Low energy** |
| RfR Deventer Project | 238.64 (Rijkswaterstaat, 2022) | 125 (Google Maps, n.d.-a) | 4.4 (Navionics, n.d.) | 0.43 | **Low energy** |
| Missouri River Levee Setback Project | 999.58 (SNOFLO, 2022) | 210 (Google Maps, n.d.-b) | 2.6 (Navionics, n.d.) | 1.83 | **High energy** |

# Appendix D – Interview details

This appendix consists of the details of the interviews that were conducted as part of this research, which can be divided into two main types of interviews. To begin with, interviews were conducted as part of the data collection procedure for the case study assessments, for which a distinction is made between interviews with (i) stakeholders that have directly been affected by the project and (ii) project experts that have been closely involved in a planning, managing or researching role for a significant part of the project duration. The details of the interviews conducted as part of data collection are provided for each of the three case studies in Table D.1.

*Table D.1 - Details of interviews conducted as part of data collection for the case study assessments.*

| Interviewee | Type / Role | Date | Field visit vs online | Duration |
|---|---|---|---|---|
| **Eddleston Water Project** | | | | |
| "Stakeholder 1" | Farmer with measures implemented on his land | 21/09/2022 | Online | 10 min. |
| "Stakeholder 2" | Farmer with measures implemented on his land | 19/09/2022 | Online | 10 min. |
| "Stakeholder 3" | Landowner, who is not predominantly a farmer, with | 15/09/2022 | Field visit | 30 min. |
| "Stakeholder 4" | Local beneficiary without any measures implemented on his land | 15/09/2022 | Field visit | 20 min. |
| "Stakeholder 5" | Local beneficiary without any measures implemented on his land | 15/09/2022 | Field visit | 10 min. |
| "Stakeholder 6" | Local beneficiary without any measures implemented on his land | 14/09/2022 | Field visit | 10 min. |
| "Project expert 1" | Researching role | 14/09/2022 | Field visit | 1.5 hours |
| "Monitoring expert 1" | Researching role | 14/09/2022 | Field visit | 15 min. |
| **RfR Deventer Project** | | | | |
| "Stakeholder 1" | Key stakeholder that was involved in & affected by the project | 06/10/2022 | Online | 25 min. |
| "Project expert 1" | Managing role | 22/09/2022 & 17/10/2022 | Field visit & online | 1 – 1.5 hours |
| "Project expert 2" | Managing role | 05/10/2022 | Online | 40 min. |
| "Project expert 3" | Managing role | 17/10/2022 | Field visit | 30 min. |
| "Monitoring expert 1" | Researching role | 26/09/2022 | Online | mail |
| "Monitoring expert 2" | Researching role | 02/10/2022 | Online | mail |
| **Missouri River Levee Setback Project** | | | | |
| "Project expert 1" | Managing role | 18/10/2022 | Online | 1 hour |
| "Project expert 2" | Planning role | 21/10/2022 | Online | 1 hour |

Furthermore, interviews were conducted as part of the reflection on the added value of the case study results. These interviews were held with project experts that have been closely involved in a managing, directing or researching role for a significant part of the project duration. The details of the interviews conducted as part of this reflection are provided for each of the three case studies in Table D.2.

*Table D.2 – Details of interviews conducted as part of reflection on the added value of the case study results.*

| **Interviewee** | **Type / Role** | **Date** | **Field visit vs online** | **Duration** |
|---|---|---|---|---|
| Project expert – Eddleston Water Project | Researching role | 01/11/2022 | Online | 30 min. |
| Project expert – RfR Deventer Project | Managing role | 02/11/2022 | Online | 20 min. |
| Project expert – Missouri River Project | Planning role | 04/11/2022 | Online | 45 min. |

# Appendix E - Indicator scores and rationale: Case study 1 - Eddleston

This appendix provides the indicator scores, rationale and means of verification for the application of the IUCN Standard to Case study 1: Eddleston Water Project. The self-assessment tool of the IUCN Standard provides additional guidance for the scoring of the indicators, which can be found in Appendix B. The actual score of the project to the indicators, together with the accompanied rationale and means of verification, are provided for each of the eight criteria in Table E.1 to E.8. The four types of means of verification used and their representative colour are as follows: publicly accessible documentation (*blue*), project expert interview (*red*), stakeholder interview with a farmer/landowner with NbS measures (*green*) and stakeholder interview with a local beneficiary without NbS measures (*orange*). The publicly accessible documentation is divided into major project-related documentation, listed in section 5.2.2 and covered under "Means of verification", and documentation with additional non-project-related data, covered under "Rationale". Furthermore, details on the interviews are provided in Appendix D. Indicators for which the indicator and accompanied guidance can be interpretated in multiple ways due to (i) insufficient details or (ii) the possibility for interpretation in a strict manner or with sound judgement are indicated with a (i) single or (ii) double red outline.

*Table E.1 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 1: "NbS effectively address societal challenges".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 1.1 | The most pressing societal challenges for rights holders and beneficiaries are prioritised | Partial | The project was not set-up such that the rights holders and beneficiaries were consulted about their challenges in advance of the project. However, the challenges that were identified as most pressing and were prioritized coincide mostly with the challenges that stakeholders mentionted to be most pressing, with the exception of human health. Therefore, even though there was no consultation, the project scores "partial" in identifying and prioritizing the most pressing challenges for rights holders and beneficiaries. | [Spray, 2017], [Project expert 1], [Stakeholder 4], [Stakeholder 6] |
| 1.2 | The societal challenges addressed are clearly understood and documented | Strong | The main drivers of and responses to the societal challenges have been identified (e.g. river straightening and embankment, railway construction along river, changes in land use and forestry) and understood. The historical context has been understood at the local context of the Eddleston catchment, as well as the national context of Scotland. This is all documented and publicly accessible. | [Spray, 2017], [Harrison, 2012] |
| 1.3 | Human wellbeing outcomes arising from the NbS are identified, benchmarked and periodically assessed | Partial | The project does not have specific targets for human wellbeing and no benchmark assessments of human wellbeing have been performed. However, "health" was assessed in a qualitative assessment of ecosystem services at a later stage of the research, considering the increased recreational visitors leading to additional physical activity. Therefore a "Partial" score is provided. | [Mott Macdonald, 2020], [Project expert 1] |

*Table E.2 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 2: "Design of NbS is informed by scale".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **2.1** | Design of NbS recognises and responds to the interactions between the economy, society and ecosystems | **Adequate** | Interactions between economy, society and ecosystems are identified (e.g. importance of most valuable agricultural land for business model of farms (economy), construction of footpath (society), most effective locations for measures (ecosystems)) and accounted for in decision-making. However, potential knock-on impacts on and from other areas/sectors have not explicitly been identified. | [Project expert 1], [Spray, 2017] |
| **2.2** | Design of NbS integrated with other complementary interventions and seeks synergies across sectors | **Adequate** | Synergies across sectors are investigated and integrated in design (e.g. forestry felling trees on the tributaries and planting of trees on agricultural land for enhance infiltration and shadow for livestock). Complementary interventions are identified (e.g. Leadburn Community Woodland and farms implementing measures), but these are not integrated within the design. However, Tweed Forum does approach these individuals/organizations to advise and align these with the project aims, which is why the project does not score lower than "Adequate". Tweed Forum is constantly revisiting these by looking for new developments in the catchment. | [Project expert 1] |
| **2.3** | Design of NbS incorporates risk identification and risk management beyond the intervention site | **Adequate** | Risks of undesirable changes and their drivers are analysed and negotiated, taking into account scientific and local knowledge (e.g. at project board meetings). These risks are taken into account in decision-making and design. but not all risks are elaborately documented and no formal risk management strategy for the entire project exists. However, elaborate risk analyses are performed for individual measures and the contractors that implement the measures do have risk management strategies. As significant attention is paid on the identification and management of risks, but there is limited documentation, the score "Adequate" is provided. | [Project expert 1] |

*Table E.3 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 3: "NbS result in net gain to biodiversity and ecosystem integrity".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **3.1** | NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss | **Strong** | The scoping study (2009/10) includes a detailed characterization of the river and catchment (incl. ecology) and a comprehensive baseline (incl. ecological measurements) is provided after the installation of the monitoring network (2011). Numerous relevant elements of the ecosystem have been assessed, incl. ecological status of river, aquatic macroinvertebrate and macrophyte and salmonid fry, at the appropriate timescale (prior to implementation) and spatial scale (control sites). The assessments include information on the drivers of change, as well as field verification and local knowledge. | [Werrity et al., 2010], [Spray et al., 2022b], [Spray, 2017], [Monitoring expert 1] |
| **3.2** | Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed | **Adequate** | One of the main targets is to improve habitats for wildelife and fish, and to improve the ecological status of the river. However, no specific and measurable targets (incl. direction, magnitude and timeframe) have been set for biodiversity conservation. As it is a research project, instead the targets for certain elements (e.g. macroinvertebrates) are to research what happens as result of the measures. These elements are benchmarked and periodically assessed in detail, such that sufficient information is yielded to indicate species or ecosystem recovery and thereby meet the targets of researching what happens. As benchmark and periodic assessments are performed in detail, but no measurable targets have been set, an "Adequate" score is provided. | [Spray et al., 2022b], [Apem, 2022], [Spray, 2017], [Project expert 1] |
| **3.3** | Monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS | **Insufficient** | Due to the nature of being a research project, scientists are monitoring specific (groups of) species (e.g. aquatic macroinvertebrates, salmon) in great detail to analyze the effectiveness of the measures. Therefore the unintended adverse consueqneces on many other species, ecological processes and ecosystems are not monitored. Additional research is done by PhD and MSc students, helping to identify uninteded consequences at a broader scope, but there are still many species and elements not monitored. There are also no actions to mitigate unintended consequences in place. | [Spray et al., 2022b], [Project expert 1], [Monitoring expert 1] |
| **3.4** | Opportunities to enhance ecosystem integrity and connectivity identified and incorporated into the NbS strategy | **Strong** | Requirements for maintaining and recovering ecosystem integrity have been assessed. The ecological status of the river had a 'Bad' ecological status according to the parameters of the EU Water Framework Directive. The aim was established to reach a 'Good' ecological status, and many NbS measures (e.g. log jams, ponds and tree planting) were implemented to enhance the ecosystem integrity and connectivity, and restore the ecological status of the river. | [Spray, 2017], [Project expert 1] |

*Table E.4 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 4: "NbS are economically viable".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 4.1 | The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented | Strong | Project documentation includes: (i) breakdown of the whole project life costs, mostly verified by key informants (e.g. Tweed Forum) and with well-founded assumptions where necessary, and (ii) estimation of each of the project benefits, using the B£ST (Benefits Estimation Tool) that was selected by the Steering Group. In addition, the winners and losers can easily be ascertained in project documentation. | [Mott Macdonald, 2020], [Spray et al., 2022] |
| 4.2 | A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies | Partial | As the project is a research project, it aims to explore the effectiveness of the measures and does not seek return on investment. Therefore, no cost-effectiveness study has been performed in advance to support the choice of NbS. However, a cost-effectiveness analysis was performed at later stage (2020), providing overview of upfront and recurring direct and indirect costs, as well as benefits over 100-year appraisal period, including key assumptions and sensitivity analyses. The analysis does not specifically cover future economic risks with respect to changes to regulations and subsidies. As the cost-effectivenes study was not provided to support the choice of NbS, and future economic risks are not covered in the analysis, a "Partial" score is provided. | [Mott Macdonald, 2020], [Project expert 1] |
| 4.3 | The effectiveness of an NbS design is justified against available alternative solutions, taking into account any associated externalities | Partial | The scoping study (publicly accessible) includes 15 possible measures that are elaborely analyzed (constraints, barriers, field investigations, GIS analyses), providing 13 locations with suitable measures. SWOT analysis provided strengths, weaknesses, opportunties and threats to justify the proposed measures (for discussion with landowners). However, affordability (and associated externalities) was not an official criterion for selection of the proposed measures. It has been considered, but not used for justification against alternatives (and not included in documentation). | [Werritty et al., 2010], [Project expert 1] |
| 4.4 | NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance | Adequate | The project operates with a 3-year funding guarantee and therefore long-term funding is not completely secured. However, over the project lifetime there have periodically been comprehensive reviews of resourcing options, and full resourcing packages have been assembled in both the scoping study as the latest project report. These included many different sources, e.g. Scottish government, EU NSR Interreg BwN program, University of Dundee, British Geologica Survey, Scottish Border Counstil and SEPA). | [Werritty et al., 2010], [Project expert 1] |

*Table E.5 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 5: "NbS is based on inclusive, transparent and empowering governance processes".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 5.1 | A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention can be initiated | Adequate | There is no formal feedback and grievance mechanism. The project is unique in this matter, which is the result of no legal agreements and Tweed Forum acting as a trusted intermediate through informal communication with stakeholders. However, a score "Adequate" is provided because feedback and grievance can still be provided to Tweed Forum. Farmers/landowners with measures mentioned that they personally know people working at Tweed Forum and local beneficiaries mentioned they would google the project, ending up at Tweed Forum. All stakeholders trust that actions will be taken, of which two had examples of actions taken after the provision of feedback. | [Project expert 1], [Stakeholder 1], [Stakeholder 2], Stakeholder 3], [Stakeholder 4], [Stakeholder 6] |
| 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) | Strong | Participation is based on mutual respect and equality: it is completely voluntarily, Tweed Forum recognizes respect as the foundation of stakeholder engagement and farmers/landowners solely had positive experiences. There are processes in place to support this throughout project timescale (e.g. project board, project steering group, one-to-one communication, public meetings) and FPIC is respected, as there are no indigenous people present at (or near) project location [Garnett et al., 2018; Native Land Digital, n.d.]. | [Tweed Forum, 2020], [Spray, 2017], [Werritty et al., 2010], [Stakeholder 1], [Stakeholder 2], [Stakeholder 3] |
| 5.3 | Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention | Strong | Elaborate stakeholder identification and analysis (impact and interests) is done for Tweed catchment, and key stakeholder for project itself were identified. Relevant stakeholders were involved in all processes of the intervention: initiation of ideas, selection of measures and locations, design of measures and implementation. All stakeholders are positive on the outcomes of the project, farmers/landowners with measures on their land feel ownership and local beneficiaries do not (logical, as not involved) | [Werritty et al., 2010], [Tweed Forum, 2020], [Stakeholder 1], [Stakeholder 2], [Stakeholder 3], [Stakeholder 4] [Stakeholder 5], [Stakeholder 6] |
| 5.4 | Decision-making processes document and respond to rights and interests of all participating and affected stakeholders | Strong | In decision-making, the rights and interests of stakeholders is taken into account. No specific attention is paid to stakeholders with extreme inequity, as this is not relevant in this case. However, if there would be cases of inequity, these would be acknowledged. All decision-making at project board meetings is documented and shared with key people. Decisions made on monitoring are documented (transparent and accessible) in monitoring reports and for other processes, fundamental decisions are documented in (project) reports (transparent and accessible). | [Spray et al., 2022b], [Spray et al., 2022a], [Spray, 2017], [Project expert 1] |
| 5.5 | Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making among the stakeholders in those jurisdictions affected by the NbS | Strong | The project area, as well as its signficant influence on ecological processes and functions, does not extend beyond jurisdictional boundaries [Scottish Government, 2020].Therefore no joint decision-making or transboundary cooperation agreements are needed. | [Project expert 1] |

*Table E.6 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 6: "NbS equitably balances trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 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 | Insufficient | Numerous trade-offs have been made, like trade-offs for design (e.g. pond for biodiversity vs flood reduction), locations of measures (e.g. best agricultural land vs most effective location) and timing (wait for more funding vs fast delivery). As it is a long-term research project, for which the collaboration with stakeholders has the highest priority, these trade-offs have been made based on trust and are not specifically documented. The project does not necessarily seek the greatest return on investment and therefore the costs and benefits of the trade-offs have not been analyzed. | [Project expert 1] |
| 6.2 | The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected | Strong | Tweed Forum did an email survey to identify stakeholder attitudes and responsibilities with farmers across the Eddleston and Tweed catchment. Furthermore, their responsibilities, but also rights, usage and access to land and resources were identified by walking around the catchment, communicating with key farmers and landowners to seek opportunities for collaboration. The collaboration is completely voluntarily, respecting the rights of the stakeholders. In addition, their responsibilities are respected through full consultation with the stakeholders on design, e.g. concerning which agricultural land is most important. A farmer with measures on his land mentioned that his rights, usage and access to land and resources have always been respected. | [Spray, 2017], [Tweed Forum, 2020], [Stakeholder 1] |
| 6.3 | Established safeguards are periodically reviewed to ensure that mutually-agreed trade-offs limits are respected and do not destabilise the entire NbS | Partial | As the trade-offs are all based on trust and not documented, the establishment of limits of trade-offs and safeguards is limited (and not documented). An example of a trade-off limit and safeguard is the recent case where a farmer was not happy with the pond on his land, because it was not deep enough, making it more of a flood pond than a biodiversity pond. The limit is that the farmer was not happy and contacted Tweed Forum, and the safeguard is that Tweed Forum is currently re-designing the pond. This example demonstrates that trade-offs are based on trust and formal establishment of limits and safeguards is not of value for this research project. | [Project expert 1] |

*Table E.7 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 7: "NbS are managed adaptively, based on evidence".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **7.1** | A NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention | **Adequate** | The scoping study includes a "Restoration strategy", which includes clear intended outcomes (economic, social and ecological) and an action plan for delivering the strategy. No special attention is paid on assumptions and how these might change. The study also includes a "Monitoring strategy", which is based on the restoration strategy. The regular execution of the monitoring strategy is confirmed by the latest monitoring report. | [Werritty et al., 2010], [Spray et al., 2022b] |
| **7.2** | A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle | **Adequate** | A robust and adaptive monitoring strategy has been in place over the entire project lifetime and has regularly been re-assessed, after which relevant adaptations have been discussed, made and documented. The monitoring strategy has been implemented at regular intervals throughout the entire project lifetime. However, the strategy does not include how deviations from the strategy trigger an adaptive management response, therefore providing an "Adequate" score. | [Werritty et al., 2010], [Spray et al., 2022b] |
| **7.3** | A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle | **Partial** | There is no formal framework for iterative learning. This would require formal feedback and this is not how the project has been set up. However, lessons learned from monitoring results are reported to the Project board every six months, acting as a learning loop. The lessons learned are discussed and incorporated in project approach during the science meetings. Examples of adaptive management applied: re-designing a pond, adjusted application of log jams and more sustainable implementation of logs at meander bends. As there is a 3-year funding guarantee, there is no strategy for learning beyond this time-period. However, it is a research program and there is high value to keep it going, so it is very likely that this will happen. "Partial" score has been provided due to (i) no framework for iterative learning, and (ii) no strategy for beyond 3 years. | [Project expert 1] |

*Table E.8 – Indicator scores, rationale and means of verification of Eddleston Water Project for Criterion 8: "NbS are sustainable and mainstreamed within an appropriate jurisdictional context".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **8.1** | NbS design, implementation and lessons learnt are shared for triggering transformative change | **Strong** | Even though there is no communication strategy in place that states how often & through which methods information must be shared and how this will trigger transformative change, the project scores "Strong". This is because the project has a large publicly accessible database [Tweed Forum, 2020] that contains project (incl. design, implementation and lessons learned), monitoring and other reports. Furthermore, it is an open research platform that provides opportunities for development of individual researches, strategic audiences are invitied to the project site and shown around, project experts give lectures at university groups and there are collaborations with local schools. These all contribute to triggering transformative change. Knowledge is shared with the general public through annual agricultural shows, the newsletter, a leaflet, interpretation boards (soon to be implemented) and local press. Stakeholders confirmed to receive project-related information through the website, data base and the (online) newsletter. | [Spray, 2017], [Spray et al., 2022b], [Stakeholder 2], [Stakeholder 4] [Stakeholder 5], [Stakeholder 6], [Project expert 1] |
| **8.2** | NbS inform and enhance facilitating policy and regulation frameworks to support its uptake and mainstreaming | **Strong** | The scoping study includes the policy and legislative context of the project. Various actions have been taken to inform and enhance facilitating policy and regulation frameworks (e.g. informing Scottish NFM network, informing the Environment Agency, informing EU INTERREG BwN project, informing the government on how the River Basin management Planning process can work alongside new FRM (Scotland) Act 2009, enhancing research recommended by the Scottish Pariamentary Committee and informing to different organizations worldwide). As all of these actions involve the sharing of knowledge and monitoring results of NbS measures, these are likely to support the uptake and mainstreaming of NbS. | [Werritty et al., 2010], [Spray, 2017], [Spray et al., 2022a], [Project expert 1] |
| **8.3** | Where relevant, NbS contribute to national and global targets for human wellbeing, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) | **Partial** | The project is closely involved with the (national) Scottish restoration targets, to which it reports its contribution. However, it has not identified and reported to any other national and global targets (for human wellbeing, climate change, biodiversity and human rights). It has been used as a case study in which it's contribution to targets is demonstrated (e.g. a research that demonstrated the contribution to nine UN SDGs) [Andrikopoulou et al., 2021], but these are not initations of the project itself. Note that the UNDRIP is not applicable in this case, as there are no indigenous people living at (or near) the project location [Garnett et al., 2018; Native Land Digital, n.d.]. | [Project expert 1] |

# Appendix F - Indicator scores and rationale: Case study 2 - Deventer

This appendix provides the indicator scores, rationale and means of verification for the application of the IUCN Standard to Case study 2: RfR Deventer Project. The self-assessment tool of the IUCN Standard provides additional guidance for the scoring of the indicators, which can be found in Appendix B. The actual score of the project against the indicators, together with the accompanied rationale and means of verification, are provided for each of the eight criteria in Table F.1 to F.8. The three types of means of verification used and their representative colour are as follows: publicly accessible documentation (*blue*), project expert interview (*red*) and stakeholder interview (*green*). The publicly accessible documentation is divided into major project-related documentation, listed in section 5.3.2 and covered under "Means of verification", and documentation with additional non-project-related data, covered under "Rationale". Furthermore, details on the interviews are provided in Appendix D. Indicators for which the indicator and accompanied guidance can be interpretated in multiple ways due to (i) insufficient details, or (ii) the possibility for interpretation in a strict manner or with sound judgement, are indicated with a (i) single or (ii) double red outline.

Table F.1 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 1: "NbS effectively address societal challenges".

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 1.1 | The most pressing societal challenges for rights holders and beneficiaries are prioritised | Adequate | The rights holders and beneficiaries were not consulted about their challenges in advance of the project, because the project is part of a national program that has prioritized two societal challenges (flood risk reduction and improval of spatial quality (i.e. ecological robustness and cultural meaning/aesthetics)) for the entire program. However, the challenges that were prioritized coincide completely with the challenges that a stakeholder mentioned to be most pressing prior to the project. Therefore, even though there was no consultation, the project scores "adequate" in identifying and prioritizing the most pressing challenges for rights holders and beneficiaries. | [Gemeente Deventer & Provincie Overijssel, 2017], [Project expert 1], [Stakeholder 1] |
| 1.2 | The societal challenges addressed are clearly understood and documented | Strong | The main drivers of and responses to the societal challenges have been identified (e.g. construction of embankments to protect houses and agricultural land, construction of groynes and weirs, dredging the river, higher river discharges due to climate change) and understood. These have been understood in national context (as part of the national program) and in local context (program used regional knowledge and expertise of experts in Deventer). This is all documented and publicly accessible. | [Gemeente Deventer & Provincie Overijssel, 2017], [Platteeuw et al., 2004], [Project expert 1] |
| 1.3 | Human wellbeing outcomes arising from the NbS are identified, benchmarked and periodically assessed | Adequate | To provide context to one of the two main objectives: "improval of spatial quality", the project established a Spatial Quality Framework [DN Urbland, 2017]. This framework includes target related to human well-being (e.g. preservation of city front; provision of recreational value to parts of the trenches; provide walking areas in the floodplains near the city; maintain existing residential buildings). These targets are not SMART (not quantied and not time-bound), but they are specific (incl. target, location, actions for accomplishment). The current situation (i.e., benchmark) of the targets is described, but this is not exact and quantified. The targets were incorporated into the project design and, during the design and implementation phase, they were periodically assessed by a local and national quality team. After the implementation phase, the targets have no longer been assessed or monitored. | [DN Urbland, 2007], [Project expert 1], [Project expert 3] |

*Table F.2 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 2: "Design of NbS is informed by scale".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **2.1** | Design of NbS recognises and responds to the interactions between the economy, society and ecosystems | **Adequate** | In the design phase of the project, the interactions between economy, society and ecosystems have elaborately been identified within and surrounding the project area, including potential changes over time and knock-on impacts on other areas (e.g. accessibility and water safety). These interactions were used for the establishment of boundary conditions for the design. However, the periodic accounting of the interactions in decision-making processes during the intervention timescale was limited, as well as the consideration of knock-on impacts from other areas. | [Gemeente Deventer & Provincie Overijssel, 2017], [Van de Laar et al, 2010b], [Stakeholder 1] |
| **2.2** | Design of NbS integrated with other complementary interventions and seeks synergies across sectors | **Strong** | Potential synergies across sectors and (plans for) complementary interventions are thorougly investigated through an assessment of autonomous developments, which included plans for development of a natural farm, plans for the "Ijsselhotel" and marina, and river widening plans outside of project area. As far as possible, these have been integrated within the project design, where a good example is the development of the natural farm, which was a plan by the foundation Ijssellandschap and did not fit in the original plan (as it's an obstacle in the floodplain), but was integrated into design due to its added value for maintenace of the floodplains by cattle grazing. These were re-assessed throughout projet time-scale. | [Gemeente Deventer & Provincie Overijssel, 2017], [Ruimtelijke plannen – Deventer, 2011], [Project expert 1] |
| **2.3** | Design of NbS incorporates risk identification and risk management beyond the intervention site | **Strong** | An elaborately identification of risks and their drivers was performed, based on local and scientific knowledge. A management plan for these risks was established through the RISMAN-method, which was used for project design and re-visited each quarter throughout the project lifetime. The risk identification and management was all documented, but not publicly accessible, except for general information on risks included in the boundary conditions for design. | [Gemeente Deventer & Provincie Overijssel, 2017], [Project expert 2] |

*Table F.3 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 3: "NbS result in net gain to biodiversity and ecosystem integrity".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 3.1 | NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss | **Adequate** | The development of (alternatives for) project actions was based on an assessment of the current status of the ecosystem, conducted in the scoping phase of the project. This assessment was performed at the appropriate spatial and temporal scale, included information on drivers of change and was based on field measurements, and scientific and local knowledge. However, it was based on secondary monitoring data and no project-specific field verification was done. Also, there was no data for certain elements (e.g., quality of the habitat types), as these were not inventorized by secondary monitoring programs/projects. | [Van de Laar et al., 2010b], [DN Urbland, 2007] |
| 3.2 | Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed | **Partial** | There are quality requirements (i.e., targets) for nature, which include biodiversity conservation, (established in the Spatial Quality Framework) and values for certain species and habitats (established in the EU Birds and Habitats Directive) that are based on a current (benchmark) assessment of the ecosystem, and should be maintained or improved. However, these targets lack specificity, do not consist of measurable indicators. In addition, the benchmark assessments also lack specificity and are not directly related to the targets. Through periodic assessments of the Spatial Quality Framework by the local and national quality teams during the design and implementation phase, the targets are qualitative assessed. After the implementation was completed, these periodic assessments stopped and solely monitoring was conducted by various parties (e.g., Foundation Ijsselandschap, Rijkswaterstaat East-Netherlands; Van Giels, 2017; Oosterwegel, 2022, Ravon), which was not linked to pre-set targets and was not part of a clear monitoring strategy for the project. | [DN Urbland, 2007], [Ruimtelijke plannen – Deventer, 2011], [Platteeuw et al., 2004], [Project expert 2], [Monitoring expert 1], [Monitoring expert 2], [Stakeholder 1] |
| 3.3 | Monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS | **Insufficient** | The project organization did not establish a clear monitoring plan for ecosystems, species and ecological processes at the project area for after the implementation phase. After implementation, the maintenance and monitoring was transferred to the landowners. The largest of the landowners is foundation Ijsselandschap, which conducts monitoring of specific plant and animal species for the province, in return for subsidies, as their land has become "nature area" after the project. However, the unintended adverse consequences on many other species, ecological processes and ecosystems are not monitored, and the elements that are monitored are not collected for project-related monitoring purposes. | [Project expert 2], [Stakeholder 1] |
| 3.4 | Opportunities to enhance ecosystem integrity and connectivity identified and incorporated into the NbS strategy | **Strong** | Requirements to maintain or recover ecosystem integrity have been assessed through, for instance, the Spatial Quality Framework and the EU Birds and Habitats directive. Three options to enhance the ecosystem integrity and connectivity were identified from the Spatial Quality Framework, of which two (development of low-dynamic marsh with seepage relations and expansion of existing valuable oak/hardwood riparian forests) were implemented after a fair trade-off with the other objectives. Next to these options, the project strategy enhances ecosystem integrity and connectivity through it's main NbS measure: the development of high water trenches, which connects natural environments within the landscape. | [Ruimtelijke plannen – Deventer, 2011], [Platteeuw et al., 2014], [Van de Laar et al., 2010a] |

*Table F.4 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 4: "NbS are economically viable".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **4.1** | The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented | **Adequate** | The direct and indirect project costs (composed of (1) property costs, (2) project preparation, and (3) implementation) and benefits, as well as who pays and who benefits, are elaborately identified and documented, but not publicly accessible. Information on the costs and benefits has been published through an EIA of the project and cost-benefit analyses of the program, but these are limited and do not provide insights into distribution of costs or "winners" and "losers". As costs, benefits, who pays and who loses are said to be identified and documented, but no claims can be made on whether the winners and losers can easily be ascertained, or whether they are completely verified, the project scores "Adequate". | [Van de Laar et al., 2010a], [Ebregt et al., 2005], [Project expert 1], [Project expert 2] |
| **4.2** | A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies | **Partial** | For the project specifically, no cost-effectiveness study has been conducted. This is because a fixed budget of the Room for the River program was provided to the project and it was set-up as such that the project objectives (flood risk reduction and improval of spatial quality) had to be met within this budget. However, the Room for the River Program did perform cost-effectiveness studies for the selection of the most-effective measures and for the alternatives of project packages. These included analyses on the measures and locations of the project. For this reason, a score "Partial" has been provided to the project. | [Ebregt, 2005], [Project expert 3] |
| **4.3** | The effectiveness of an NbS design is justified against available alternative solutions, taking into account any associated externalities | **Adequate** | Three alternatives were identified, compared and discussed with stakeholders, leading to a "Preferred Alternative" (i.e., PA). Consequently, this alternative was optimized as a "Most Environmental Friendly Alternative". After elaborate comparison, the PA was selected as the final project design, where its effectiveness and affordability were justified against the "Most Environmental Friendly Alternative". The comparison of the effectiveness and costs of both alternatives, and the final choice for the PA are documented, but the justification for the PA (larger contribution to flood risk reduction at the expensive of additional achievement of nature goals) lacks documentation. | [Van de Laar et al., 2010a], [Hartgers et al., 2015], [Project expert 2] |
| **4.4** | NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance | **Strong** | As the project is part of the national program "Room for the River", which is funded by the government of the Netherlands, a comprehensive review of resourcing options and assemblance of a resourcing package are not relevant. For the program, a review of resourcing options was conducted in [Ministerie van Verkeer en Waterstaat, 2015] , which (next to the funding from the project budget from the government) identified supplementary receipts from real estate, EU grants, agency contribution and project-related receipts. A full resourcing package for the project was assembled and re-assessed every 6 months in the progress reports of the program. This resourcing package was developed based on cost estimations for implementation of all projects, and therefore included future revenue streams. | [Ruimtelijke plannen – Deventer, 2011] |

*Table F.5 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 5: "NbS is based on inclusive, transparent and empowering governance processes".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **5.1** | A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention can be initiated | **Adequate** | The project has a formal feedback and grievance mechanism through two ways: (1) There is a "Sounding Board" that consists of residents of the project area or the near vicinity, representing interest groups. This group can provide feedback and grievance, as it advises the project organization on all formal decisions; (2) Consultation meetings were organized in which all affected stakeholders could provide their feedback and grievance. Stakeholders were not consulted for the development of this mechanism, but the mechanism was established to be accessible, predictable, equitable, transparent, rights-compatible and documented. Furthermore, a stakeholder mentioned he/she trusts the mechanism for the provision of feedback and grievance, and experiences the basic attitude of other stakeholders to be the same. | [Ruimtelijke plannen – Deventer, 2011], [Van de Laar et al., 2010a], [Stakeholder 1], [Project expert 3] |
| **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) | **Adequate** | Stakeholder experienced participation to be based on mutual respect and equality, regardless of gender or age. All affected stakeholders had the possibility to participate, but the stakeholder experienced some frustration at smaller stakeholder groups that felt treated unequally in relation to the larger, more prominent groups. There were several processes in place to support participation throughout the project lifetime, such as the "Steering group" (most prominent organizations), the "Sounding Board" (representatives of interest groups), walk-in evenings, consultation meetings and the environmental manager as a trusted intermediate. However, these processes were experienced to be less supportive during the implementation phase and were directly disbanded after implementation. FPIC is respected, as there are no indigenous people present at (or near) project location [Garnett et al., 2018; Native Land Digital, n.d.]. | [Ruimtelijke plannen – Deventer, 2011], [Van de Laar et al., 2010a], [Stakeholder 1], [Project expert 1] |
| **5.3** | Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention | **Adequate** | The project executed an elaborate stakeholder identification and analysis, in which the impact and interests of stakeholders were mapped. Affected stakeholders were involved in many processes throughout the project lifetime, such as the project start notition, alternative development, preliminary design and the zoning plan. Landowners were also involved in implementation, maintenance and monitoring. Apart from involvement with regard to activities on the land of stakeholders, there was limited stakeholder involvement after the start of implementation. Stakeholder mentioned that he accepts the project and feels strong ownership. Acceptance by other stakeholders cannot be substantiated, but it is likely that some stakeholders (e.g. that were somehow negatively impacts or not happy with the large changes that were made) did not (completely) accept the project. | [Ruimtelijke plannen – Deventer, 2011], [Gemeente Deventer & Provincie Overijssel, 2007], [Stakeholder 1], [Project expert 1] |
| **5.4** | Decision-making processes document and respond to rights and interests of all participating and affected stakeholders | **Adequate** | The decision-making process takes into account the rights and interests of stakeholders: (i) Sounding board (representatives of all interest groups) provides advise on all formal decisions; (ii) Input at consultation meetings. No specific attention is paid to stakeholders with extreme inequity, but (1) this is (nearly) irrelevant in a well developed country like the Netherlands, (2) all affected stakeholders are allowed to provide input through the interest groups and consultation meetings. Stakeholder mentioned he/she had very positive experiences with the acknowledgement of his input, but also experienced that input of other stakeholders had less weight in the decision-making. The decision-making is documented, but solely the most relevant documentation is accessible (project reports and progress reports of the program [Rijkswaterstaat, n.d.-b]). | [Van de Laar et al., 2010a], [Stakeholder 1], [Project expert 1] |
| **5.5** | Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making among the stakeholders in those jurisdictions affected by the NbS | **Strong** | It is identified that the project area (and nearby influence) extends beyond jurisdictional boundaries: (i) provinces 'Gelderland' and 'Overijssel', (ii) municipalities 'Deventer', 'Voorst' and 'Olst-Wijhe' [Gemeentenatlas, 2022], (iii) Water boards 'Groot Salland' (now called 'Drents Overijsselse Delta') and 'Vallei and Veluwe' [De Nederlandse Gemalen Stichting, n.d.]. Transboundary cooperation and joint decision-making is created through the inclusion of all provinces, municipalities and water boards in the steering group, which takes care of the administrative coordination between the authorities involved. Furthermore, affected stakeholders in all jurisdictions are able to participate through the stakeholder participation processes. | [Ruimtelijke plannen – Deventer, 2011], [Van de Laar et al., 2010a] |

*Table F.6 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 6: "NbS equitably balances trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **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 | **Adequate** | The project organization explicitly identified, acknowledged and documented the costs and benefits of trade-offs, at project and larger landscape scale. These trade-offs were addressed at the front, during the design process, where trade-off limits were established in the Spatial Quality Framework of the project and when these limits were passed, safeguards would be implemented through e.g. adjusting the trade-off (or, if it would have been necessary, compensate with e.g. new areas of nature). However, the project organization did not re-assess the trade-off limits after the start of implementation. Lastly, decision-making on specific trade-offs is solely disclosed to directly affected stakeholders, and main decisions made are covered in the project and program reports. | [Project expert 1], [Project expert 2] |
| **6.2** | The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected | **Strong** | The rights, usage of and access to land and resources have been identified and incorporated in the planning regulations in the zoning plan. The stakeholder responsibilities have been identified and incorporated in the stakeholder analysis. Both are acknowledged and respected; as the project was part of a national program funded by the government, all decisions made had to be justified and reported back to the government. Also, both were used to inform the design of the project. | [Ruimtelijke plannen – Deventer, 2011], [Stakeholder 1], [Project expert 1] |
| **6.3** | Established safeguards are periodically reviewed to ensure that mutually-agreed trade-offs limits are respected and do not destabilise the entire NbS | **Partial** | Mutually agreed upon trade-off limits are established and documented in the Spatial Quality Framework of the project, and are being respected carefully througout design process. The design is developed such that the trade-off limits are not exceeded by adjusting trade-offs and implementing safeguards. However, safeguards have not been established to prevent trade-off limits being exceeded after the start of implementation. These are therefore not periodically reviewed and documented after the completion of design. | [Project expert 2] |

*Table F.7 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 7: "NbS are managed adaptively, based on evidence".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **7.1** | A NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention | **Partial** | The project did not establish a project strategy that precisely states the intended outcomes and exact actions and assumptions made to achieve these outcomes. However, the intended outcomes are precisely stated in other documentation. Also, based on the selected preferred alternative, a layout plan was established (which could be considered as a limited project strategy), which for each region of the project area states: (i) a number of (non-specific) intended outcomes for that region, and (ii) a number of actions for layout of the area to address the intended outcomes and account for potential adverse influences from outside the region. A number of assumptions in regards to economic, social and ecological conditions are included in this plan, but these do not take into account whether and how the assumptions might change. There is no link between the layout plan and a monitoring and evaluation plan established for the project. | [Ruimtelijke plannen – Deventer, 2011], [DN Urbland, 2007], [Project expert 3] |
| **7.2** | A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle | **Partial** | There is no specific monitoring and evaluation plan in place, as the Room for the River Program was solely an implementation program. Except for the monitoring of the groundwater level, no project-specific monitoring is executed during design or implementation phase. After the implementation phase, monitoring is transferred to the landowners. Therefore no adaptive management responses were planned or executed based on a monitoring plan. However, the project did have an elaborate risk management plan that includes adaptive management responses. Each risk-session (each quarter), the risks and adaptive management responses were evaluated, and if necessary, adaptive management responses were executed. The evaluation of risks and potential triggers of adaptive management responses also stopped after the implementation phase. As, through the risk management plan and risk-sessions, periodic evaluations (during design and implementation) were done and adaptive management responses were executed if required, a score "Partial" is provided. | [Project expert 2], [Project expert 3] |
| **7.3** | A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle | **Adequate** | Iterative learning and adaptive management is included in the risk management plan. This is not in response to a monitoring plan, but it is in response of periodic evaluations (each quarter) of the risks and adaptive management responses, resulting in learning experiences (e.g. better identification of bombs from the second world war) and execution of adaptive management responses. After the implementation phase was completed, the project organization was disbanded. There was no strategy for iterative learning beyond this moment, monitoring and evaluation were transferred to the landowners and not checked or collected, and there was no adaptive management anymore. As there was an iterative learning framework (through the risk management plan) that regularly enabled adaptive management based on periodic evaluations, the score "Adequate" is provided. | [Stakeholder 1], [Project expert 2], [Project expert 3] |

*Table F.8 – Indicator scores, rationale and means of verification of RfR Deventer Project for Criterion 8: "NbS are sustainable and mainstreamed within an appropriate jurisdictional context".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **8.1** | NbS design, implementation and lessons learnt are shared for triggering transformative change | **Adequate** | As part of the Room for the River Program, a lot of attention was spend on systematically capturing the project. General information on design, implementation and lessons learned is shared publicly through project and program reports, as well as at a project office in the marina, through excursions with primary schools, art projects, in numerous articles in newspapers and more. Sharing of design, implementation and lessons learned is also done with strategic audiences (e.g. sharing of preliminary designs with Sounding Board or sharing of lessons learned at a congress). Even though these forms of sharing project information most likely did contribute to triggering transformative change, they were not necessarily initiated with this purpose. Furthermore, not all project information is shared on demand. The national program has a communication strategy, which was developed according to the method "Het Strategisch Communicatieframe" [Wissink, n.d.]. Again, even though the sharing of project information by the project and program is likely to trigger transformative change, it cannot be substantiated whether the communication (strategy) detailed how transformative change would be triggered. As (i) not all information is shared on demand, (ii) additional effort could have been spent on sharing project information with the purpose of triggerering transformative change, and (iii) it is not clear whether this is included in the strategy, a score "Adequate" is obtained. | [Ruimtelijke plannen – Deventer, 2011], [Van de Laar et al., 2010a], [Project expert 1], [Project expert 2], [Stakeholder 1] |
| **8.2** | NbS inform and enhance facilitating policy and regulation frameworks to support its uptake and mainstreaming | **Partial** | An elaborate policy framework was established, in which European, provincial and municipal policies, as well as regulations and laws, relevant to the project were identified (e.g. EU Birds and Habitats Directive (linked to Natura 2000-areas), EU Flood Directive, Soil Protection Act, 1988 Monuments Act and Spatial Planning Act). The impact of these policies, regulations and laws was mapped in the framework, and were taken into account as part of the project design. Also, the project periodically informed the Dutch Parliament on the project during the design and implementation phase. However, opportunities within the policies and laws to support the uptake and mainstreaming of NbS were not mapped. Neither did the project communicate or take actions to inform or enhance facilitating policy and regulation frameworks, with the aim of uptaking and mainstreaming the concept of NbS. | [Ruimtelijke plannen – Deventer, 2011], [Project expert 3] |
| **8.3** | Where relevant, NbS contribute to national and global targets for human wellbeing, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) | **Insufficient** | The project did not identify any national or global targets for human well-being, climate change, biodiversity and/or human rights. This can partly be explained by the fact that the project was completed in 2015 and the project organization was disbanded afterwards, while many of these targets had just been/were not yet established (e.g. UN SDGs in 2015). However, the contribution to the targets that did exist, and to the targets that were established afterwards, was not reported to the platforms and therefore did also did not facilitate mainstreaming and upscaling of the project or NbS concept. Note that the UNDRIP is not applicable in this case, as there are no indigenous people living at (or near) the project location [Garnett et al., 2018; Native Land Digital, n.d.]. | [Project expert 2] |

# Appendix G - Indicator scores and rationale: Case study 3 - Missouri

This appendix provides the indicator scores, rationale and means of verification for the application of the IUCN Standard to Case study 3: Missouri River Levee Setback Project. The self-assessment tool of the IUCN Standard provides additional guidance for the scoring of the indicators, which can be found in Appendix B. The actual score of the project against the indicators, together with the accompanied rationale and means of verification, are provided for each of the eight criteria in Table G.1 to G.8. The two types of means of verification used and their representative colour are as follows: publicly accessible documentation (*blue*) and project expert interview (*red*). The publicly accessible documentation is divided into major project-related documentation, listed in section 5.4.2 and covered under "Means of verification", and documentation with additional non-project-related data, covered under "Rationale". Furthermore, details on the interviews are provided in Appendix D. Indicators for which the indicator and accompanied guidance can be interpretated in multiple ways due to (i) insufficient details or (ii) the possibility for interpretation in a strict manner or with sound judgement are indicated with a (i) single or (ii) double red outline.

*Table G.1 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 1: "NbS effectively address societal challenges".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 1.1 | The most pressing societal challenges for rights holders and beneficiaries are prioritised | Adequate | The rights holders and beneficiaries were not consulted about their challeges in advance of the project, as the L-575 levee setbacks were executed in response of the 2011 Missouri River Flood, as part of the PL 84-99 Emergency Levee Rehabilitation Program, with the main purpose to repair the levee to pre-flood level of protection or setback sections of the levee where severe damage has occured, as soon as possible. Therefore, the prioritized challenge was (flood) risk reduction, and even though incidental environmental benefits result from large-scale levee setbacks, environmental degradation and biodiversity loss were not prioritized. Considering the catastrophic floods, it can be stated that the societal challenge prioritized coincides with the most pressing challenge(s) for stakeholders at that time, even though no stakeholder interviews were conducted. For this reason, even though rights holders and beneficiaries were not consulted, a score "Adequate" is provided. | [USACE, 2013b], [Project expert 1] |
| 1.2 | The societal challenges addressed are clearly understood and documented | Strong | The main drivers of and responses to the prioritized societal challenge (flood risk reduction) have been identified and understood at both local context (L-575 levee unit) and national context (Missouri River Basin). These have been understood for the Missouri 2011 floods specifically (e.g. extremely heavy spring rains, larger amounts of snow melt runoff) and throughout the last centuries, which is more elaborately covered in [IFMRC, 1994]. Also, the drivers (Missouri River Bank Stabilization and Navigation project) and responses (Missouri River Recovery Program) to environmental degradation and biodiversity loss along the Missouri River and at the project area have been identified and understood. This is all documented and publicly accessible. | [Krause et al., 2015], [USACE, 2013a], [Smith et al., 2017] |
| 1.3 | Human wellbeing outcomes arising from the NbS are identified, benchmarked and periodically assessed | Partial | The project does not have targets for human wellbeing and no benchmark assessments of human wellbeing have been performed. However, after completion of both L-575 levee setbacks, a public notice was shared to receive public responses to evaluate the impacts of the project on, among others, aesthetics, land use, navigation, recreation, safety, property ownership, and needs and welfare of people, which can be encompassed by human well-being. Therefore, a one-time assessment of various elements related to human well-being has indirectly been performed. | [USACE, 2013b], [Project expert 1] |

*Table G.2 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 2: "Design of NbS is informed by scale".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **2.1** | Design of NbS recognises and responds to the interactions between the economy, society and ecosystems | **Adequate** | Even though the project area solely consisted of conservation land, owned by the USACE through the MRRP, and therefore there were no/limited interactions between economy, society and ecosystems, the project managed to identify and incorporate interactions between economy, society and ecosystems in design in two ways. (1) Levee setbacks: economy (least cost alternative); society (e.g. recreation possibilities, like hunting, fishing and walking, for people from Nebraska city); ecosystems (enhanced ecosystem connectivity and habitat development). (2) Borrow pits: economy (material for levee construction that is nearby and cheap); society (interior ponding for interior drainage of landowner nearby); ecosystem (adjusted slopes/shapes to enhance habitat development). These include interactions within and surrounding the project area, and are accounted for in decision-making. Hydraulic knock on impacts on other areas are elaborately analyzed, but no effort is put in the identification of other knock on impacts on or from other areas. Furthermore, the change in the interactions over time has not been considered. | [USACE, 2013a], [Project expert 1], [Project expert 2] |
| **2.2** | Design of NbS integrated with other complementary interventions and seeks synergies across sectors | **Adequate** | Two complementary interventions were identified and integrated in design: (1) levee setback was done such that an existing highway bridge could be modified to have more conveyance under the bridge in the future; (2) parts of the old levee were remained, such that there is high ground for bird perching. Synergies across sectors were investigated, resulting in the borrow pits that are beneficial to various sectors. It was stressed by the project expert that, as the entire project area was conservation land owned by the USACE through MRRP, there were limited possibilities for synergies across sectors and integration of complementary interventions, and that in is opinion all opportunities were utilized. The complementary interventions and synergies were not re-assessed throughout the project lifetime. | [Project expert 1], [Project expert 2] |
| **2.3** | Design of NbS incorporates risk identification and risk management beyond the intervention site | **Partial** | Risk analysis and management for the project were limited. Prior to the project, a risk analysis was performed by means of a hydraulic model such that there were no adverse hydraulic impacts up- or downstream (for 100-year event). As part of the PL 84-99 Emergency Levee Rehabilitation Program, environmental risks of nonstructural responses (not project-specific) were identified. After the project, as part of the USACE Levee Safety Program, the levee sponsor has been responsible for identification and management of flood risks related to the levee. Documentation on these analyses and management is lacking. Apart from these analyses, no project-specific risk analysis has been performed and no risk management plan has been established. This can be explained by the largest risk of not rehabilitating the levee as soon as possible and the limited time for elaborate analyses as result of that. | [USACE, 2013a], [USACE, 2018], [Project expert 1], [Project expert 2] |

*Table G.3 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 3: "NbS result in net gain to biodiversity and ecosystem integrity".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **3.1** | NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss | **Partial** | As part of the 2011 Tiered Environmental Assessment, the current state of the relevant ecosystems of the project have been assessed, including limited information on drivers. This assessment has been based on limited historic knowledge and secondary monitoring that was conducted by different agencies throughout the years. The collected data is relatively basic and not specific to the project area. Vegetation surveys after the 2011 flood were done, but these were very basic and no other field verification has been done. There is no relation between the project actions and this assessment, and therefore a score "Partial" is provided. | [USACE, 2013a], [Project expert 2] |
| **3.2** | Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed | **Partial** | The project did not establish targets for biodiversity conservation. However, the project area is conservation land as part of Missouri River Recovery Program, which aims to maximize the ecological function of the area and does have SMART targets for biodiversity conservation [MRRP, 2019]. The project contributes to the targets of the program. Apart from the limited baseline assessment explained in rationale for indicator 3.1, no benchmark assessment have been performed. Periodic assessments/monitoring was executed, but this was not related to pre-set targets, very limited, not consistent and unorganized (not part of a monitoring plan). Examples of periodic assessments for biodiversity are (i) a few years of vegetation surveys along Missouri River by USACE, (ii) a few years of multi-species monitoring by Iowa Department of Natural Resources, (iii) a summer of small fish monitoring at Frazor Bend setback by Nebraska Game and Parks; (iv) four bird surveys during construction of HWY2 setback during construction. | [Krause et al., 2015], [USACE, 2013a], [Project expert 2] |
| **3.3** | Monitoring includes periodic assessments for unintended adverse consequences on nature arising from the NbS | **Insufficient** | There was no monitoring plan in place for ecosystems, species and ecological processes. There were various, unrelated monitoring efforts (as explained in rationale for indicator 3.2) that could have captured unintended adverse consequences on nature, but these were not initiated for that purpose and not part of an overarching program. Also, after completion of the levee setbacks, a public notice was shared to receive public responses on, amongst others, conservation, general environmental concerns, fish and wildlife values, which could have provided information on unintended adverse consequences on nature. There was no plan for actions to mitigate unintended consequences for nature that could have been captured in these two ways. | [USACE, 2013b], [Project expert 2] |
| **3.4** | Opportunities to enhance ecosystem integrity and connectivity identified and incorporated into the NbS strategy | **Adequate** | Potential requirements to maintain or recover ecosystem integrity were not identified prior to the project. Instead, as the project was part of PL 84-99, the levee had to be rehabilitation or set back as soon as possible, while trying to mitigate the environmental impacts by this measure as much as possible. In order to do this, opportunities to enhance ecosystem connectivity and integrity were analyzed and actions were implemented in response to these opportunities (not to requirements): (i) levee setback reconnects the river with its floodplains, creating overbank hydrologic connectivity and groundwater upwelling connectivity, increasing the topographical diversity of the floodplain and enhancing habitat development; (ii) adjustment of borrow pits (shaping to incorporate depth diversity, irregular bank lines, gentle side slopes and seeding) to encourage wetland establishment. | [Krause et al., 2015], [Project expert 1], [Project expert 2] |

*Table G.4 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 4: "NbS are economically viable".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 4.1 | The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented | Partial | The two L-575 levee setbacks were constructed as a least-cost alternative. As such, no cost-benefit analysis has been conducted and project-specific benefits (and accompanied winners) have not been identified. The direct and indirect project costs have been identified, verified with key informants and documented. Who pays for the costs (i.e., losers) cannot easily be ascertained from publicly accessible documentation, as this is not clearly stated. This could solely be identified by careful analysis of regulations described in the project documentations or talking with project experts. Shortly after implementation of the HWY2 setback started, the Assessment of Conceptual Nonstructural Alternative Levee Setbacks (ACNALS) along the Missouri River was published, which includes an elaborate cost-benefit analysis, incl. winners and losers, of repair-in-line versus three conceptual levee setbacks nearby the two L-575 setbacks. | [Krause et al., 2015], [USACE, 2013a], [Project expert 2] |
| 4.2 | A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies | Adequate | Through PL 84-99, the least cost alternative is completely funded by the federal government. For this reason, the levee setbacks were selected as a least-cost alternative, which was solely based on a cost analysis and therefore no cost-effectiveness analysis was conducted. The cost analysis, on a general level, includes upfront and recurring direct and indirect costs, key assumptions and the impact of certain regulations/subsidies. An elaborate sensitivity analysis against various critical variables has not been conducted. As the cost analysis takes into account various important elements and supports the choice of the levee setbacks, a score "Adequate" is provided. In addition, the cost-benefit analysis in the ACNALS report (see rationale for indicator 4.1), published during construction, supports the action of pursuing the option of a levee setback along that section of the Missouri River. | [Krause et al., 2015], [USACE, 2013a], [Project expert 2] |
| 4.3 | The effectiveness of an NbS design is justified against available alternative solutions, taking into account any associated externalities | Partial | No elaborate alternative study was conducted. During the in-line levee repairs on L-575, it became noticed that the sub-surface conditions of the levee were poor (e.g. a lot of under seepage and pin boils) and that it would require sheet piles or an extensive seepage blanket, which would increase the costs. Due to these high costs, the alternative of doing a levee setback was identified. The selection choice for levee setbacks was economically justified against the alternative of repair-in-line. This economic justification was documeted. Other than economically, the levee setbacks have not been justified against the alternative. As no alternative study was done and the choice of levee setbacks vs repair-in-line was solely based on economic justification, a score "Partial" is provided. | [Krause et al., 2015], [Project expert 1], [Project expert 2] |
| 4.4 | NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance | Partial | There was no comprehensive review of resourcing options and no resourcing package has been assembled, as these were not required. As the levee setback was the least-cost alternative and was not designed as betterment with respect to the old levee, the construction was completely funded by the government. Furthermore, the land was all owned by the USACE as conservation land under MRRP, and the construction material was retrieved from borrow pits on this land. Potential costs of delivery of benefits was not of relevance, as the only objective of the project (under PL 84-99) was to rehabilitate or set back the levee. Therefore, the costs were funded by the federal government and the levee sponsor had very limited to no additional costs. | [Krause et al., 2015], [Project expert 1], [Project expert 2] |

*Table G.5 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 5: "NbS is based on inclusive, transparent and empowering governance processes".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 5.1 | A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention can be initiated | Insufficient | No feedback and grievance resolution mechanism was developed, which can be explained in two ways: (i) project was part of PL 84-99 Emergency Program that aimed to quickly respond to the emergency, rather than having an elaborate planning effort, and (ii) the project area was all owned by the USACE as conservation land through MRRP, which resulted in a very limited amount of stakeholders (note: at nearby L-536 levee setback, there were various landowners and therefore more attention was paid to feedback and grievance provision). After implementation, a public notice was shared to collect comments from stakeholders. but this is considered as insufficient in terms of providing possibilities for feedback and grievance. No further information could be collected due to the absence of stakeholder interviews. Based on the collected data, the project scores "Insufficient". | [USACE, 2013b], [Project expert 2] |
| 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) | Partial | As the project area is owned by the USACE as conservation land, the only affected stakeholder that the USACE directly deals with is the levee sponsor. Participation of the levee sponsor is based on mutual respect and supported throughout the project lifetime (e.g. decision whether or not a setback is done, additional technical analysis to reassure their worries, operation and maintenance). However, apart from the levee sponsor, no attention is spent on the identification and participation of other affected stakeholders during design and implementation. The only form of equal participation of stakeholders was the public notice, which was shared after implementation. This public notice, specifically included it was also soliciting comments from Indian Tribes. Furthermore, the MRRP which covers the project area pays special attention to native American tribes and upholds the right of Indigenous Peoples to FPIC [USACE, n.d.-a]. | [USACE, 2013b], [Project expert 1], [Project expert 2] |
| 5.3 | Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention | Partial | As part of the PL 84-99 Emergency Program and accompanied limited planning effort, no elaborate stakeholder identification and mapping have been conducted. The main stakeholder involved was the levee sponsor, who are also the project proponent, and were involved elaborately in various processes throughout the project lifetime. As the land was conservation land owned by USACE through MRRP, there were no affected landowners. For the construction of the levee setback and the borrow pits, there was coordination with the Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFW), Iowa Department of Natural Resources (IDNR), Missouri Department of Conservation (MDC) and Corps Omaha District Archeologists. However, there was no involvement of stakeholder (groups) other than the levee sponsor prior to and after implementation, and no other affected stakeholders have been identified and involved. Based on information provided by project experts and enthusiastic response of stakeholders at other sections of the levee that now also show interest in levee setbacks, it can be assumed that, in general, stakeholders accept (and feel ownership) of the project. However, further substantiation would require interviews with the levee sponsor and other involved stakeholders. | [USACE, 2013a], [Project expert 1], [Project expert 2] |
| 5.4 | Decision-making processes document and respond to rights and interests of all participating and affected stakeholders | Partial | The decision-making process is documented, where the primary planning documents are not publicly accessible, but the process is summarized in the Environmental Assessment, which is publicly available. As no stakeholder identification or mapping has been conducted, the decision-making does not take into account the rights and interests of all stakeholders that are affected by the project. | [USACE, 2013a], [Project expert 2] |
| 5.5 | Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making among the stakeholders in those jurisdictions affected by the NbS | Strong | It was identified that the project area, as well as its significant influence on ecological processes and functions, does not extend beyond the jurisdictional boundaries of Omaha District [USACE, n.d.-b]. Furthermore, the project scale does only cover one levee sponsor. Therefore no joint decision-making or transboundary cooperation agreements are needed. | [Project expert 1] |

*Table G.6 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 6: "NbS equitably balances trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits.*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| 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 | Insufficient | Both large trade-offs (e.g. repair-in-line versus with under seepage control versus levee setback) and smaller trade-offs (e.g. retrieve material from standard locations or borrow pits in floodplain, and how to incorporate the Highway overpad) were made. The costs and benefits of these trade-offs were not identified and not acknowledged, as this did not align with the timeline of a quick rehabilitation under PL 84-99. Also, the making of trade-offs was not approached as trying to hit certain tresholds or stay within certain boundaries. Therefore, no trade-off limits and safeguards were established. Decision-making regarding the trade-offs was solely in collaboration with and disclosed to the levee sponsor. | [Farmer, 2013], [Project expert 1], [Project expert 2] |
| 6.2 | The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders are acknowledged and respected | Adequate | In the regulations of the PL 84-99 program, it was identified that, typically, the levee sponsor is responsible for supplying the land, as well as the borrow material (resources). It was also identified that, in this particular case, all land at the project area was owned in quiet title by the USACE through the MRRP, which alleviated the need for the levee sponsor to provide the land and borrow land. The responsibilities of the USACE through the MRRP, as well as of the levee sponsor were identified, but no further identification of responsibilities of stakeholders from beyond the project area was done (i.e., no stakeholder analysis or mapping was conducted). The identified rights and responsibilities were acknowledged, respected and inform project design (e.g. levee is set back such that it solely covers conservation land owned by USACE and borrow pits were adjusted for wetland development, which is in line with the responsibilities of MRRP). However, this could not be substantiated by the view of involved stakeholders, because of the absence of stakeholder interviews. | [Krause et al., 2015], [USACE, 2013a], [Project expert 2] |
| 6.3 | Established safeguards are periodically reviewed to ensure that mutually-agreed trade-offs limits are respected and do not destabilise the entire NbS | Insufficient | No (mutually agreed upon) trade-off limits have been considered or established, and no safeguards have been established or put in place. | [Project expert 1], [Project expert 2] |

*Table G.7 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 7: "NbS are managed adaptively, based on evidence".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **7.1** | A NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention | **Partial** | Project documentation includes a concise strategy for how the project addresses the societal challenge it prioritized (flood risk reduction), as well as how it mitigates environmental impact. This includes actions and intended outcomes, but information on assumptions, and whether and how these might change is very limited. Furthermore, the strategy is not used as a basis for monitoring or evaluation of the project. | [USACE, 2013a], [Project expert 2] |
| **7.2** | A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle | **Partial** | Specific to the project, no monitoring and evaluation plan is in place, no organized monitoring is implemented and there is no plan for how deviations of intended outcomes trigger adaptive management responses. There are monitoring efforts by various parties, but these are not organized from a project perspective and not related to adaptive management responses. After implementation of the levee setback, the levee sponsor is responsible for operation and maintenance of the levee through the "Levee Owner's Manual For Non-federal Flood Control Works" [USACE, 2006], which includes what elements require to be evaluated and which deviations trigger adaptive management responses. The compliance with evaluations and adaptive management in this manual is evaluated yearly through levee inspections by the USACE. As there is a plan for evaluation and adaptive management responses with regard to the levee, after implementation, a score "Partial" is provided. | [Project expert 1], [Project expert 2] |
| **7.3** | A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle | **Insufficient** | There is no plan or framework to (iteratively) learn and adapt in response to a monitoring and evaluation plan: (a) there is no project-specific monitoring and evaluation plan, and (b) there is no plan to learn from or adapt the project based on the operation and maintenance plan for the levee sponsor. Furthermore, there is no strategy for how learning persists beyond the time frame of the project. | [USACE, 2018], [Project expert 1], [Project expert 2] |

*Table G.8 – Indicator scores, rationale and means of verification of Missouri River Levee Setback Project for Criterion 8: "NbS are mainstreamed beyond standalone, time bound interventions".*

| Indicator No. | Indicator | Score of adherence of project to indicator | Rationale | Means of verification |
|---|---|---|---|---|
| **8.1** | NbS design, implementation and lessons learnt are shared for triggering transformative change | **Partial** | Information on project design, implementation and/or lessons learnt have been shared with strategic audiences (e.g. articles [Farmer, 2013], news briefs [Farmer et al., 2012] and conference visits) and on demand (e.g. replying to request for levee setback documentation from state of California). There are barriers to the accessibility of these forms of sharing as result of limited visibility of the used platforms. The extent to which information was shared with stakeholders cannot be substantiated due to the absence of stakeholder interviews. There is no communication strategy in place and the sharing of knowledge was done with the aim of sharing the success story, rather than triggering transformative change. Sharing of information on the L-575 setback likely played a role in triggering transformative change within the USACE Omaha District, but the sharing of knowledge to trigger transformative change (implementing levee setbacks as NbS and maximizing environmental benefits) on a larger scale has only recently started. Examples are sharing of the L-536 Playbook [The Nature Conservancy, 2021] and a change in the message during e.g. conference visits. As the information shared during the project, as well as in the years after the project was limited in its accessibility and not initiated with the aim of triggering transformative change, a score "Partial" is provided. | [Krause et al., 2015], [Smith et al., 2017], [Farmer, 2013], [Project expert 1], [Project expert 2] |
| **8.2** | NbS inform and enhance facilitating policy and regulation frameworks to support its uptake and mainstreaming | **Partial** | Various policies, regulations and laws relevant to the project have been identified (e.g. list of twenty-four environmental laws and policies, USACE Engineering Regulation (ER) 500-1-1 [USACE, 2001] and several flood control acts). The impact of these policies, regulations and laws was mapped and accounted for in project design (e.g. compliance with all relevant environmental laws and policies, and regulation in ER 500-1-1 that construction of least-cost alternative is funded for 100 percent by the federal government). Opportunities within the policies and laws to support the uptake and mainstreaming of NbS were not mapped. Neither did the project communicate or take actions to inform or enhance facilitating policy and regulation frameworks, with the aim of uptaking and mainstreaming the concept of NbS. | [Krause et al., 2015], [USACE, 2013a], [Project expert 1] |
| **8.3** | Where relevant, NbS contribute to national and global targets for human wellbeing, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) | **Insufficient** | The project did not identify any national or global targets for human well-being, climate change, biodiversity and/or human rights (incl UNDRIP). Even though the USACE was aware that the project had benefits to biodiversity and human well-being, it was not implemented as a NbS or EwN and contribution to national or global targets was never considered or reported to relevant platforms (to facilitate mainstreaming and upscaling of the project or NbS concept). | [Krause et al., 2015], [USACE, 2013a], [Project expert 1] |