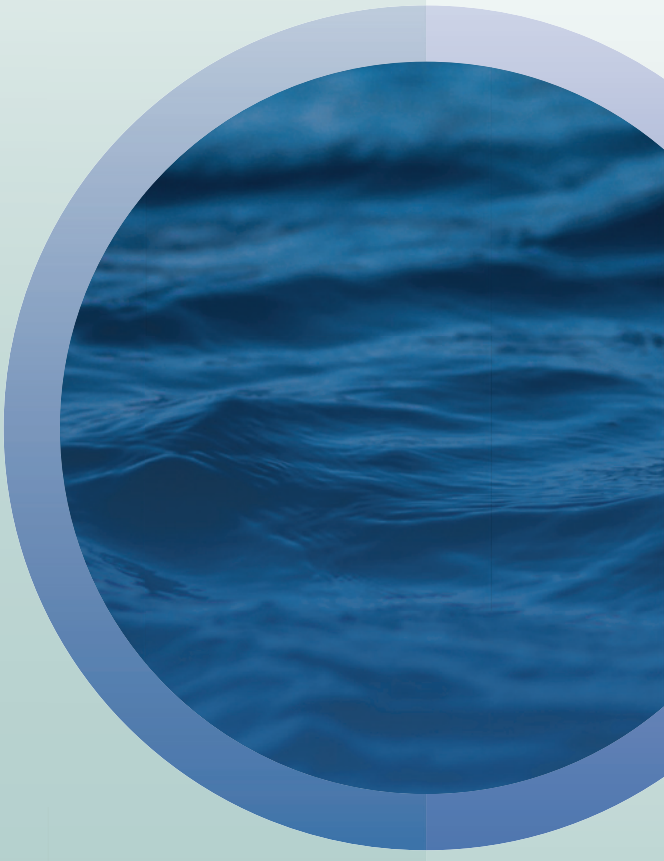
NATURE-BASED SOLUTIONS FOR WATER IN THE PERI-URBAN

A HANDBOOK FOR PRACTITIONERS

To promote and inspire implementation of
nature-based solutions in peri-urban areas



Water JPI Water Works 2017
2018 JOINT CALL

NATWIP

CONTENTS

What is NATWiP?

NATWiP is an acronym for a project entitled:

Nature-Based Solutions for Water Management in the PeriUrban: Linking Ecological, Social and Economic Dimensions.

This is an EU-Cooperation project funded under the Water Joint Programming Initiative (JPI) Call 2018 and is led by an international consortium of scientists (see Author list). The NATWiP team works towards promoting sustainable implemention of nature-based solutions to address water challenges in peri-urban areas.

EDITORS

Alanna J. Rebelo

Conservation Ecology and Entomology, Stellenbosch University, South Africa

Karen Esler

Conservation Ecology and Entomology, Stellenbosch University, South Africa

Nandita Singh

School of Natural Sciences, Technology and Environmental Studies, Södertörn University, Stockholm, Sweden

AUTHORS

Agnieszka Ewa Latawiec
International Institute for Sustainability /Centre for Conservation and Sustainability Science, Rio de Janeiro, Brazil

Alanna J. Rebelo
Conservation Ecology and Entomology, Stellenbosch University, South Africa ●

Aline Furtado Rodrigues
International Institute for Sustainability/Centre for Conservation and Sustainability Science,
Rio de Janeiro, Brazil

Amy Oen
RiSC, Norwegian Geotechnical Institute, Oslo, Norway

Andrea Ramírez-Agudelo,
Universitat Politècnica de Catalunya, BarcelonaTech, Institute for Sustainability Sciences and Technology,
Barcelona, Spain

Elisabet Roca
Universitat Politècnica de Catalunya, BarcelonaTech, Institute for Sustainability Sciences and Technology, Barcelona, Spain

Karen Esler
Conservation Ecology and Entomology, Stellenbosch University, South Africa

Nandita Singh
School of Natural Sciences, Technology and Environmental Studies, Södertörn University, Stockholm, Sweden

Nupur Bose
A.N. College, Patliputra University, Patna, India

Ratna Amrit
A.N. College, Patliputra University, Patna, India

Lina Suleiman
Department of Urban Planning and Environment, School of Architecture and the Built Environment, KTH, Royal Institute of Technology, Stockholm, Sweden

Sarah Hale
Sustainable Geosolutions, Norwegian Geotechnical Institute, Oslo, Norway

Veronica Maioli
International Institute for Sustainability /Centre for Conservation and Sustainability Science, Rio de Janeiro, Brazil

THE PURPOSE OF THE NATWiP HANDBOOK

This handbook provides guidance on the holistic consideration of nature-based solutions to support water sustainability in peri-urban areas.

The reader is presented with an innovative, holistic and operational framework that has been developed through transdisciplinary processes. The framework considers all three phases of nature-based solutions, the first being the socio-spatial context assessment (research and planning phase), the second is the implementation processes (implementation phase) and the third is the evaluation of results, including long-term results, unintended consequences and co-benefits (monitoring and evaluation phase).

For each of these three phases, three sustainability dimensions are considered: environmental, social, and economic. The framework includes a set of indicators for each dimension within each of the three phases that can be adapted to local contexts.

This means that even though the NATWiP Framework focusses primarily on peri-urban areas and water-related nature-based solutions, it can be applied more broadly. Users may consider applying the framework as a tool to evaluate ongoing projects and to guide new ones, across different countries, landscapes and contexts.

The handbook provides a brief overview of concepts in **Chapter 1**, with a description in **Chapter 2** of the methodological framework. **Chapter 3** offers step-by-step instructions on how to apply the NATWiP Framework. **Chapter 4** illustrates how to apply this framework, through a series of case studies gathered from across the world. The case studies are at various stages of planning or implementation. Finally, in **Chapter 5** main lessons learnt from the case studies are drawn together and seven principles of best practice for nature-based solutions – aiming to be sustainable – are proposed. The handbook concludes with **Chapter 6**.

While this handbook does not provide technical guidelines for nature-based solutions, it is intended for anyone. Practitioners or researchers who want to consider a more holistic framing of nature-based solutions may use this framework for designing, implementing, or monitoring and evaluation purposes.

The over-arching aim of the NATWiP Framework is to ensure that sustainable development goals are explicitly considered in water-related, nature-based solutions projects, in order to catalyse the United Nations *2030 Agenda for Sustainable Development* (for more on the *2030 Agenda*, please see ***Three dimensions of sustainable development***, in **Chapter 1**).

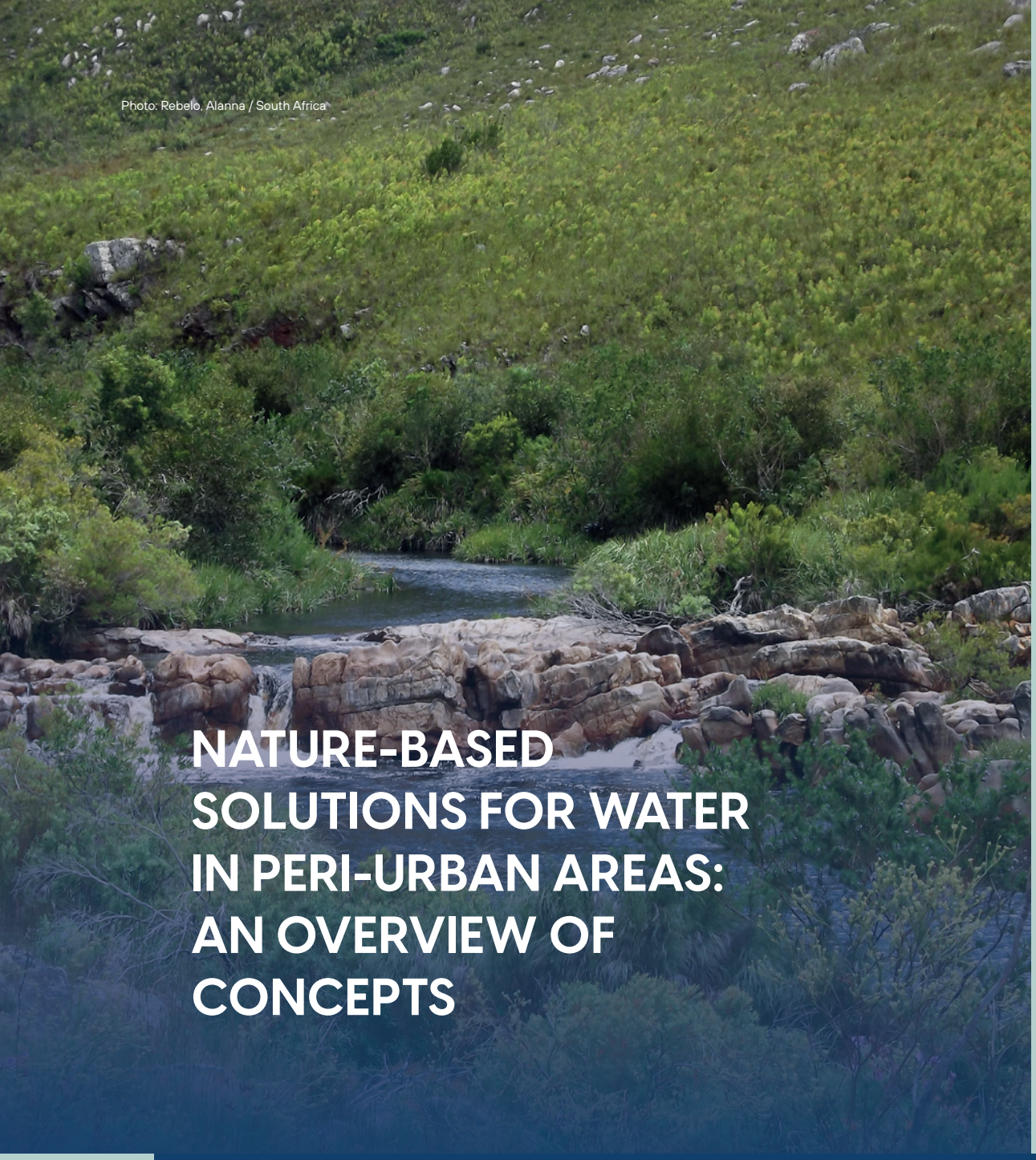


Photo: Rebelo, Alanna / South Africa

NATURE-BASED SOLUTIONS FOR WATER IN PERI-URBAN AREAS: AN OVERVIEW OF CONCEPTS

CHAPTER 1

In this chapter a brief overview of concepts (including some important definitions) and an introduction to some key resources is provided. This is followed by a brief "State of the Art" of nature-based solutions for water management in peri-urban areas.

It is important to note that there are already critical resources on nature-based solutions available to the public. Some of these have been listed below. The aim of this handbook is not to replicate, nor to replace these, but to complement them.

One available resource is the *International Union for Conservation of Nature (IUCN) Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of nature-based solutions* (IUCN 2020).

The *Nature-based Solutions Triple Win Toolkit – International Climate Finance Evidence Project* produced by the Joint Nature Conservation Committee of the United Kingdom (JNCC 2021) is another accessible resource. Short overviews for each of these resources are provided below.

Please note that this handbook is not intended to review or present all resources on nature-based solutions that are available to the public. It merely points readers to some of the key resources.

While this handbook does lay out some principles for best practice – specifically for nature-based solutions to *water challenges in peri-urban areas* based on the literature and case studies (**Chapter 5**) – its focus is rather on the introduction of the NATWiP Framework. The framework aims to provide a method to assess and design nature-based solutions and how to implement it effectively (**Chapter 2**, **Chapter 3, Chapter 4**).

KEY RESOURCES

The *IUCN Global Standard for Nature-based Solutions* presents a robust and systematic learning framework to improve and evolve the application of nature-based solutions. Utilising it may lead to greater confidence in nature-based solutions among decision makers and avoid further inconsistent and ungrounded applications (IUCN 2020*).*

Eight criteria for nature-based solutions are laid out in detail, accompanied by examples from various case studies around the world. According to the *IUCN Global Standard,* nature-based solutions should:

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

The *Nature-based Solutions Triple Win Toolkit* is based on the concept of a '*triple win'*. When applied appropriately, the specific nature-based solutions achieve the following: biodiversity is enhanced, climate change is addressed and poverty is reduced (JNCC 2021). These three simultaneous, beneficial outcomes represent the 'triple win'.

The *Triple Win Toolkit* is based on an analysis of 2934 projects and 460 indicators. Nine principles have been distilled that could help nature-based solutions projects achieve a 'triple win':

1. each of the three essential pillars of the 'triple win' framework (namely: biodiversity, climate and people) should be considered equally – in other words, no one pillar is more important than the other two,
2. engage local communities in a participatory approach,
3. account for site-specific and complex dynamic contexts,
4. put in place social and environmental safeguards,
5. design with longevity and futureproofing in mind,

6. build robust, long-term monitoring systems,
7. emphasise an adaptive management approach,
8. provide sustainable, equitable financial incentives; and
9. consider trade-offs and synergies across multiple scales.

In reference to principle 1 above, the *Triple Win Toolkit* emphasises the need to treat the enhancement of biodiversity as an explicit objective. As one of the three equal pillars in achieving a 'triple win', this aspect is just as important as addressing the impacts of climate change or reducing poverty.

Finally, this resource outlines barriers to private investment in nature-based solutions and suggests possible models for leveraging investment.

KEY DEFINITIONS

Nature-based solutions for water management are actions that are inspired by, supported by, or replicated by, nature to address a wide range of water issues. These unique solutions solve societal challenges and may provide multiple benefits (Bauduceau *et al.* 2015; Cohen-Shacham *et al.* 2016).

Some examples of nature-based solutions, specifically for water management, include: river parks, wetlands, ecological restoration, agroforestry, sustainable urban drainage systems, green roofs or walls, rainwater harvesting, rain gardens, and permeable pavements, among others.

Water challenges are identified in the NATWiP Framework across three broad categories: too much water (flooding), too little water (droughts) and poor water quality. Examples of issues that may lead to these water-related challenges include: unsustainable water abstraction or withdrawals, pollution, inadequate or failing infrastructure and climate change.

Peri-urban areas exist between urban and rural or natural areas and are viewed as transitional spaces. Such areas tend to have a mix of urban and rural land uses. Similar terms include: fringe area, urban peripheries, suburbs, sprawls, and "territories in between".

The pressures of urbanisation processes and climate change are often amplified in peri-urban areas, as is the effect on land cover, land use, land management, and planning.

Peri urban areas are multifunctional in character and there are many different stakeholders with diverging interests. Quite often there are entities that have overlapping mandates in terms of managing water in these areas.

Three dimensions of sustainable development: environmental, social and economic. The United Nations *2030 Agenda for Sustainable Development* commits the global community to "*achieving sustainable development in its three dimensions—economic, social and environmental—in a balanced and integrated manner*".

Co-benefits refer to the unintended positive side-effects of a nature-based solution. First advanced within the climate change literature, synonyms include: ancillary benefits, secondary benefits, and collateral benefits.

Well-being may refer to: happiness, harmony, identity, fulfilment, self-respect, community, transcendence, enlightenment, health, wealth, leisure, mobility, knowledge, communication, consumer goods (please refer to *The Daly Triangle*).

Indicators are specific and observable attributes that provide a sign or a signal that something exists or is true. Indicators can be used to assess baseline conditions; the state of processes; and results obtained. This enables the assessment of progress towards desired outcomes of a nature-based solution. Both quantitative and qualitative indicators can be used to monitor the progress or outcomes of nature-based solutions.

Actors may be individuals, groups, or institutions that participate in – and play a specific role in – an action or process. In the context of nature-based solutions, an actor has a direct interest in the project and may be involved in any of the three phases. Examples include a government agency concerned with enabling policy (signatory to Convention on Biological Diversity, Aichi targets) or landowners.

CURRENT KNOWLEDGE ON NATURE-BASED SOLUTIONS

In 2020 a review was published by Ramírez-Agudelo *et al.* of the current knowledge on the implementation of nature-based solutions for peri-urban area water management. It includes 35 international experiences that identify barriers and lessons learnt when implementing different types of nature-based solutions.

The different elements of governance (for e.g. policy instruments, organizations and roles) were shown to be vital for linking the environmental, social and economic dimensions in nature-based solutions.

As a result, a benchmark is provided that deals with the water cycle gap and water management in these areas.

Findings in this review served as the conceptual basis to examine the definition of nature-based solutions and its development as a policy concept. It also identifies details on the implementation of nature-based solutions for water management, such as the practical applications, tools and assessments. This helped form the basis for the outline and development of the NATWiP Framework (see **Chapter 2**).

Research on nature-based solutions is often focussed on assessment, tools and as a response to climate change. An important feature of nature-based solutions is that it finds *sustainable* solutions to problems.

In the literature described by Ramírez-Agudelo *et al.*, the nature-based solutions definition has been widely examined. The characterisation of nature-based solutions as an 'umbrella' concept relates to its comprehensive approach to achieving systemic interventions that deliver multiple benefits to multiple stakeholders in a resource-efficient manner.

The 2020 review explored the keywords used in nature-based solutions literature to examine cross-cutting topics. The literature highlights the process of nature-based solutions implementation as that of dynamic change, being shaped by its nature of problem-solving, as well as being highly context-specific. The review also found that nature-based solutions – regardless of their type, scale, or location – have the potential to provide multiple benefits and services.

LESSONS LEARNT

Several success factors and barriers that could favour or obstruct, respectively, the implementation of nature-based solutions were highlighted from the literature by Ramírez-Agudelo *et al.*

Success factors:

1. **Good communication**

This is a critical tool among various stakeholders and organisations (public authorities, private actors and industry, academia and research, civil society and community-based collectives etc.).

2. **Consideration of different roles and responsibilities**

Recognition of the fact that nature-based solutions implementation involves different stakeholders with different roles, at multiple levels of decision-making and territorial scales (from local to national, or regional).

3. **Monitoring change**

This is highlighted as being important, considering the different sectors that may be associated (e.g. water, transport, urban planning, energy, food, sports, health, cultural etc.). This is where the NATWiP Framework is able to add significant value.

Barriers:

1. **Complexity**

The complexity of a comprehensive approach to nature-based solutions may lead to technical, institutional, economic and social uncertainties.

2. **Technological/Infrastructural limitations**

There is often a lack of technological capacity or a lack of necessary infrastructure when it comes to nature-based solutions.

3. **Institutional capacity**

Even if public authorities are playing a vital role in the promotion of a nature-based solutions, by funding it and promoting research and policies, there may be

limitations to institutional capacity. These may have economic repercussions.

4. Alternative business models

Alternative business models are sometimes weak or unconvincing. This could restrict strategic partnerships and support for nature-based solutions by private actors.

5. Involvement of diverse actors

The interaction between a diverse group of actors involved in nature-based solutions could promote greater advances in actionable knowledge, wider perspectives, and constructive discussions.

By building on current knowledge and by incorporating various dimensions of sustainability (e.g. environment, society and economics), the NATWiP Framework (**Chapter 2**) addresses a critical gap in the existing literature. It is therefore a state-of-the-art tool for implementors and researchers.

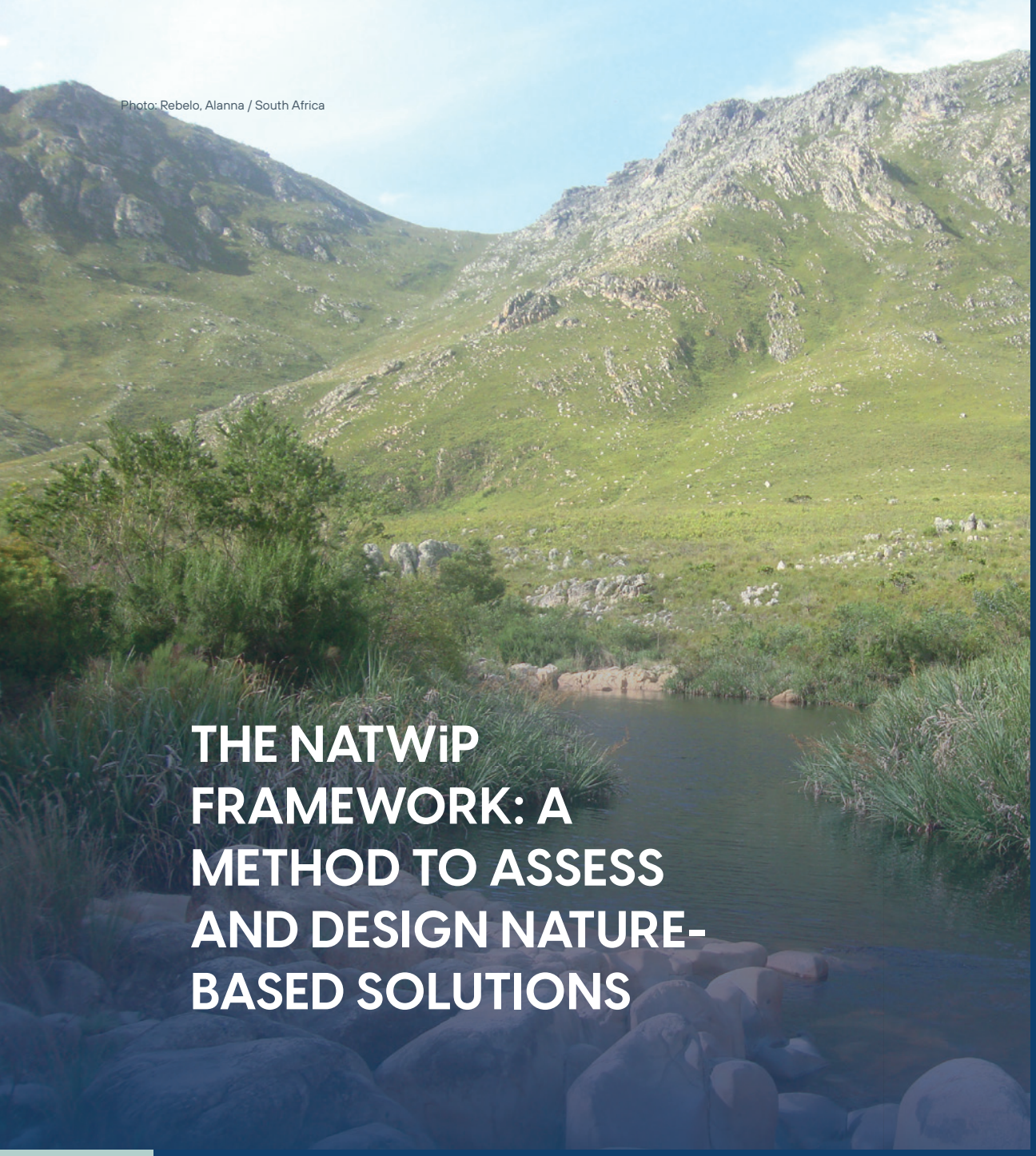


Photo: Rebelo, Alanna / South Africa

THE NATWiP FRAMEWORK: A METHOD TO ASSESS AND DESIGN NATURE-BASED SOLUTIONS

CHAPTER 2

The process of monitoring and evaluation is an essential aspect of any project or intervention. It helps to identify whether the aims and goals of the project are being met; expands on the available evidence; ensures accountability transparency; and, if needed, starts adaptive management to correct any issues. This process is especially important in nature-based solutions projects, as they can guide the use of natural resources and the inclusion of different stakeholders in decision making.

Frameworks typically focus on quantifying current or future benefits, often not capturing the multiple and integrated impacts of nature-based solutions. In addition, they are also mainly developed for urban contexts. Most frameworks also neglect long-term results, unintended consequences, co-benefits and contributions to the United Nations *2030 Agenda for Sustainable Development Goals*.

The NATWiP nature-based solutions framework proposed by Lima *et al.* (2022) is innovative because it proposes the identification of relationships between the sustainable development goals and the nature-based solution project objectives. Here the reader is reminded that these sustainability goals are aligned with the three sustainability dimensions (environmental, social and economic); and they are applicable to peri-urban areas and other settlement types. Importantly, it is a flexible and adaptable framework that can be used in different spatial, social and environmental contexts.

The NATWiP Framework may be used as a tool to guide implementation and evaluation of an entire nature-based solutions project, from the baseline through to monitoring impacts after the project is implemented.

For ongoing projects, the framework can be used as a logical guide to analyse the implemented project structure and to identify the relationship between the context, the targets and the results. Ideally, by means of an adaptive management process, this may lead to necessary adjustments and adaptations to improve sustainability outcomes.

The framework was developed after a systematic literature review (**Chapter 1**) that identified gaps and patterns in other nature-based solutions frameworks and related literature, as well as during workshops with the NATWiP Project team.

Lima *et al.* (2022) propose two forms of the framework: one is conceptual (**Figure 1**) and the other is operational (**Figure 2**). Looking first at the Conceptual Framework (**Figure 1**), it is represented by a simple, visual scheme. The aim of the scheme is to summarise the main concepts and processes of the operational framework. The different phases of the planning cycle provide a logical flow to the Conceptual Framework. Concepts of 'co-benefits' and 'well-being' are highlighted as outcomes of the nature-based solution, which might be identified in the medium or long term.

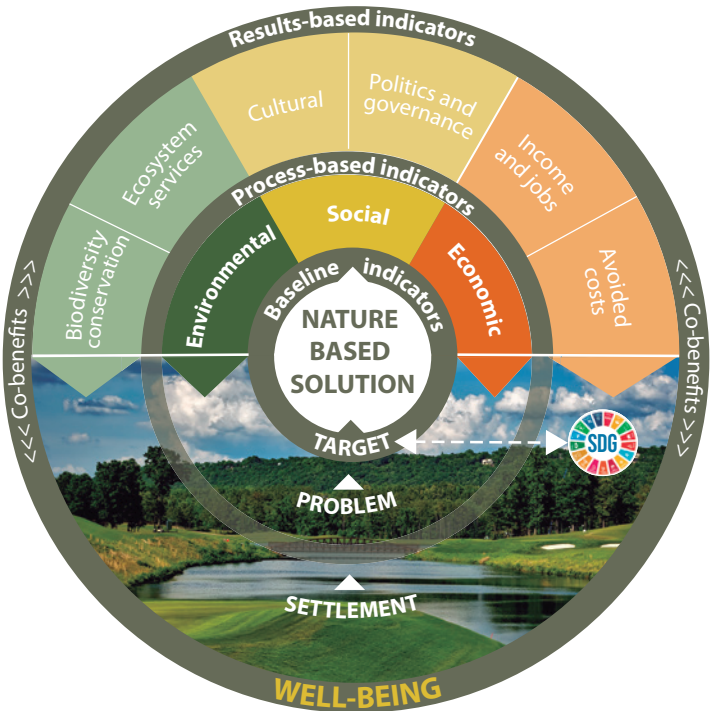


Figure 1. The NATWiP nature-based solution Conceptual Framework (Lima *et al.* 2022). "SDG" indicates 'sustainable development goals'.

When designing a nature-based solution the departure point is 'well-being' and the specific setting and problem need to be identified and defined. Once this has been done, the target can be defined and the nature-based solution can be designed.

Baseline indicators can then be developed and assessed in order to understand the context and to have baseline conditions to compare results to. These indicators correspond to the three dimensions of sustainability: environmental, social and economic.

When the nature-based solution is implemented, process-based indicators can be developed and assessed. These assess how the process is unfolding – also in terms of the three dimensions of sustainability.

Lastly, when the nature-based solution has been implemented, result indicators can be developed and assessed. This can be done either after the project, or as part of continuous monitoring and evaluation. The results may also produce co-benefits. This framework allows for the capturing of these co-benefits and other indicators from each of the three dimensions of sustainability.

On the other hand, the Operational Framework (**Figure 2**) is a complete plan that can be followed step-by-step and applied to design and implement a nature-based solution. It may be applied either at the start of a project or it may be used to monitor a project after implementation.

There are three main phases to the Operational Framework (each phase corresponding to one of the boxes in **Figure 2**):

1. The spatial context assessment
2. The nature-based solution implementation process
3. The results

These three phases are organised in a logical flow following time (indicated by 'Temporal scale'). They are also related to different planning cycle phases (top, bold arrows in **Figure 2**), common to every nature-based solution project.

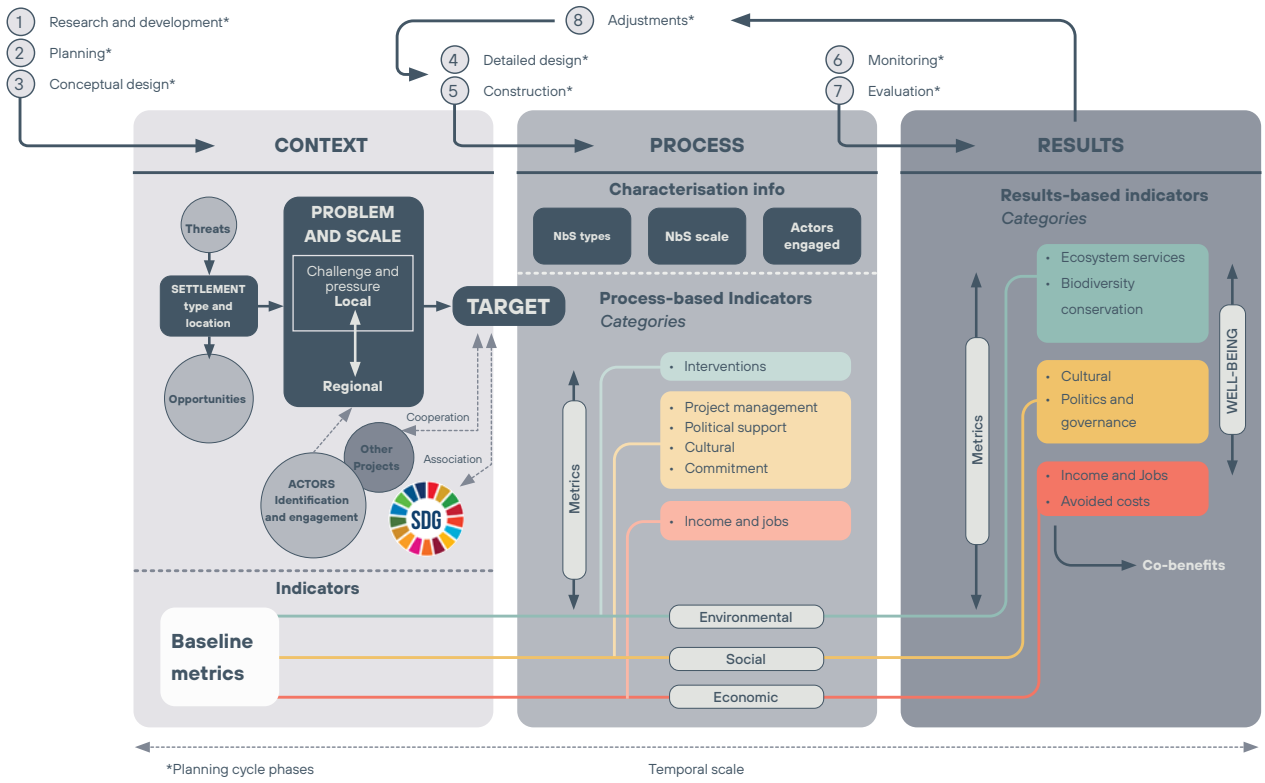


Figure 2. Lima, A.P.M., Rodrigues, A.F., Latawiec, A.E., Dib, V., Gomes, F., Maioli, V., Pena, I., Tubenchlak, F., Rebelo, A., Esler, K., Oen, A., Ramírez-Agudelo, N.A., Bosch, E.R., Singh, N., Suleiman, L., Hale, S.(2022). Framework for planning and evaluation of nature-based solutions for water in peri-urban. Landscape and Urban Planning.

The first phase of the Operational Framework (box 1, **Figure 2**) is the socio-spatial context with elements that should be identified and assessed to implement or monitor a nature-based solution project successfully. The nature-based solution has to be designed according to this context, the type of settlement and its location, with the aim of solving a well-identified problem. Consideration has to be given to the threats and opportunities associated with it, as well as to the local and regional stakeholders involved.

In this initial phase it is also important to establish the project targets that can be associated with sustainable development goals (or other projects in the region). Consider how these goals influence the design of actions, including definitions of the desired impacts, as well as specific nature-based solutions. Here the importance of defining the baseline indicators that make it possible to quantify the impact of the project activities is highlighted. The indicators allow a before-and-after snapshot of the interventions.

The second phase of the Operational Framework (box 2, **Figure 2**) details the process of characterisation and design of the actions. These include defining the nature-based solution types and scale (consistent with the problem and scale identified in box 1) and the stakeholders engaged in the implementation of the nature-based solution.

Aiming to support evaluation and monitoring, the NATWiP Framework indicates process-based indicators that are divided into categories, associated with three main sustainable dimensions (environmental, social and economic).

In the third and final phase (box 3, **Figure 2**) result-based indicators are shown that are associated with the sustainability dimensions identified in the previous phase. These should help assess whether the planned actions resulted in the desired impacts, generating co-benefits and well-being to society – locally or regionally. If not, the framework assists in identifying which adjustments should be made to improve the process and the project interventions.

The indicators were categorised as being either process-based or results-based, according to the Theory of Change approach. Process-based indicators provide information on implementation of nature-based solutions. Results-based indicators measure how effective nature-based solutions are. However, indicators should be selected case by case, depending on the social context, targets and defined goal(s). That is why the NATWiP Framework proposes broad categories and indicators, which are mainly based on analyses from the NATWiP Project case studies (Chapter 4).

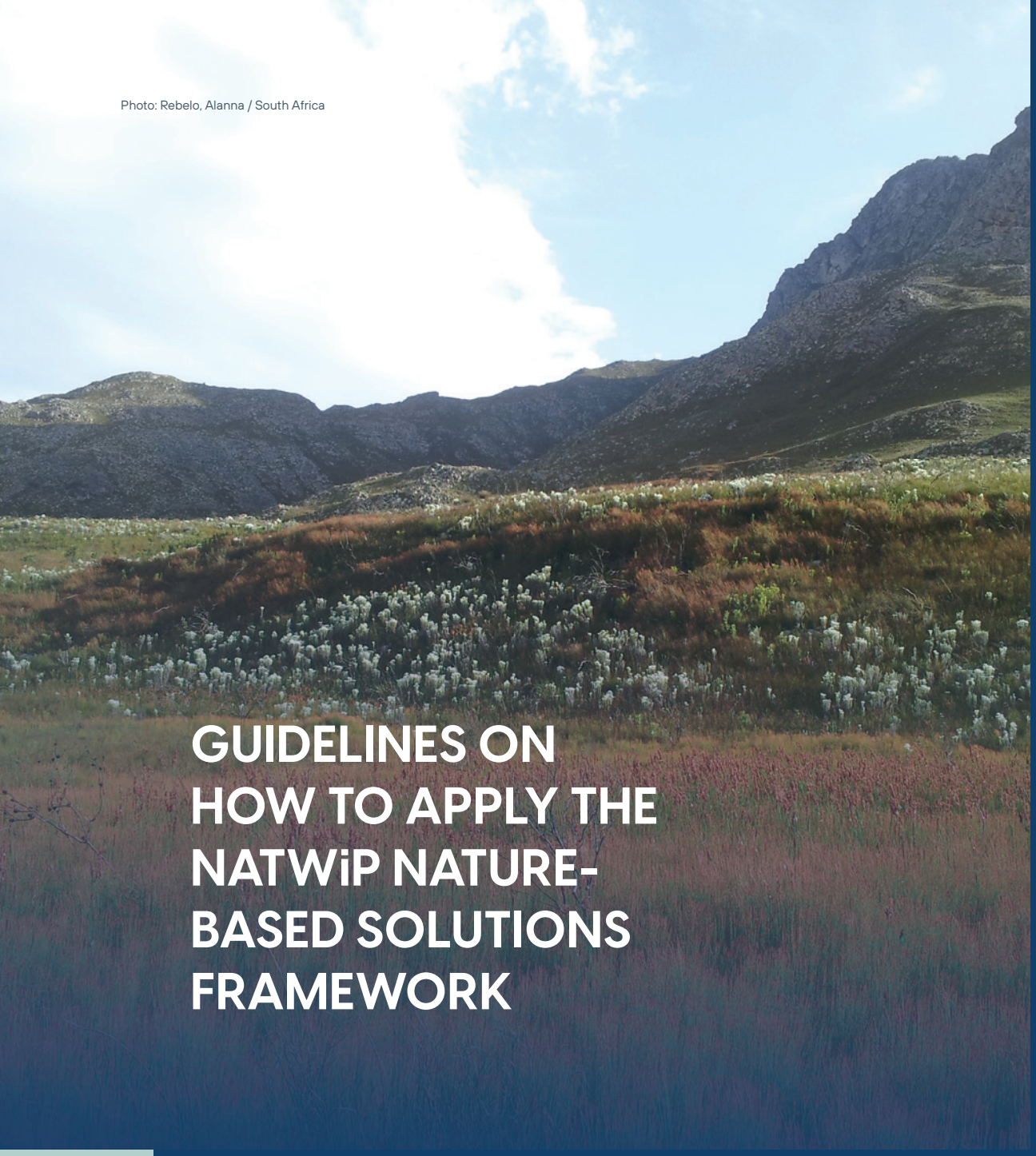


Photo: Rebelo, Alanna / South Africa

GUIDELINES ON HOW TO APPLY THE NATWiP NATURE-BASED SOLUTIONS FRAMEWORK

CHAPTER 3

The NATWiP Framework has a flexible structure that can be adjusted to relevant projects (and their unique context), as well as to each of the three sustainability dimensions (environmental, social, economic) and implementation phases (research and planning; implementation; monitoring and evaluation).

Likewise, all information required to apply the framework can be collected through various methods, such as questionnaires or mapping or monitoring of the nature-based solution project.

The framework structure proposes a logical flow of information to guide projects before, during and after implementation. At the start of a project (e.g. during the research, planning and conceptual phase), the framework can be used as a guide to highlight the main information that must be considered, acquired and accounted for *before* nature-based solutions activities are implemented.

If a project has started and the nature-based solution is already implemented, the framework can be used in one of two ways. It can either be used to organize data and evaluate processes and results to identify necessary adjustments; or it can be used to quantify results and benefits. To assist practitioners in applying the framework in a more organic way, a simple step-by-step scheme is proposed (**Figure 3**).

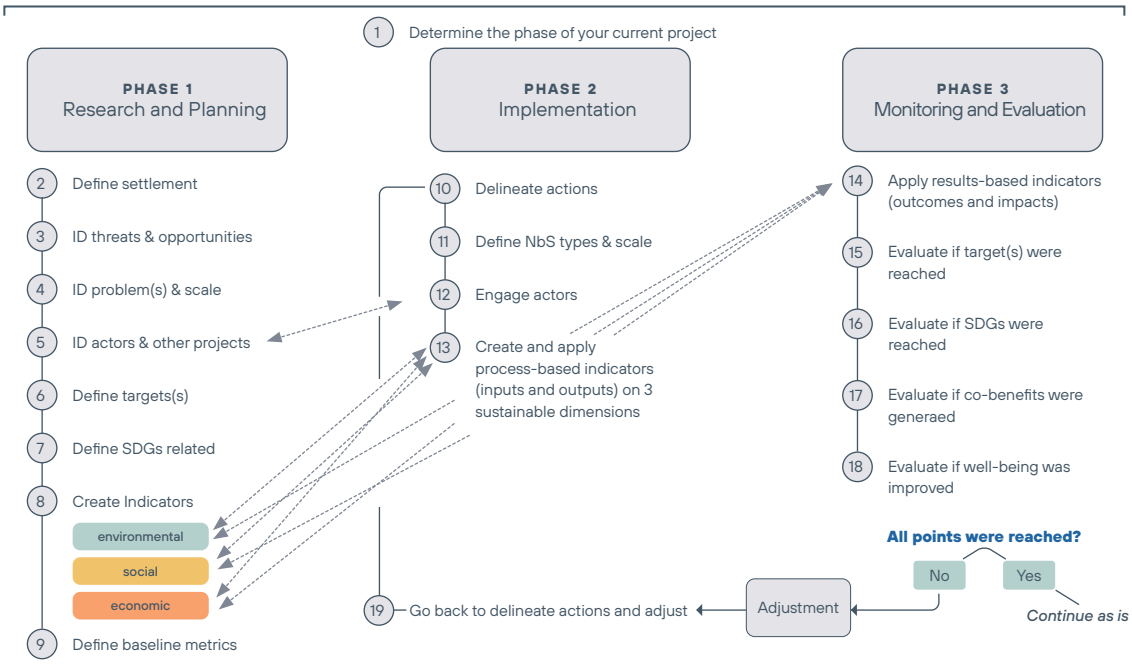


Figure 3. Step-by-step guide to apply the NATWiP Framework to any nature-based solutions case study, whether in the research and planning phase, the implementation phase or the monitoring and evaluation phase. Numbers indicate process steps. "NbS" implies 'nature-based solutions'; "ID" refers to 'identify'; "SDG" indicates sustainable development goals'.

PHASE 1 – RESEARCH AND PLANNING

The first step is to identify the **phase** of a specific nature-based solutions project (step 1). Even if the project is not yet completed (e.g. implementation – **Phase 2,** or monitoring and evaluation – **Phase 3**), the framework can still be used.

In **Phase 1**, information should be gathered about the project area and the type of settlement (step 2) (e.g. if it is a rural, urban or peri-urban space). Threats and opportunities need to be mapped out (step 3) and all stakeholders involved in that settlement type should be identified (step 5). Each settlement type may have different problems. It is therefore crucial to adequately identify the specific problem and problem scale (step 4) that the nature-based solution will address. In addition, it is recommended that any other local projects and actors addressing similar problems be identified. This may highlight possible cooperation efforts that aim to optimise efforts and results (step 5).

Based on the above mentioned contextual details, project target(s) need to be defined (step 6). Their relationship to the sustainable development goals

should then be mapped out (step 7). This will determine if and how the project contributes to the *2030 Agenda*. The target(s) needs to be aligned with the problems and with the nature-based solutions (for example, if the problem is water scarcity and the objective is to improve water quantity, then a nature-based solution might be ecological restoration).

In concluding the research and planning phase, the only remaining steps are to create indicators (step 8), according to the three sustainability dimensions (these will help measure the project's impact), and to define baseline metrics (step 9) that will attest to the state of the settlements *before* the implementation of project activities.

PHASE 2 – IMPLEMENTATION

The second phase (**Phase 2**) involves the detailed implementation of nature-based solutions activities. In this phase precise actions must be laid out (step 10) to achieve the targets previously defined (step 6).

Following is the definition of the nature-based solution type and scale (step 11). The nature-based solution will be constructed according to the contextual details identified in the research and planning phase (steps 2-4). For example, if there is a problem at a watershed scale, the nature-based solution should be designed at a watershed scale.

To successfully implement nature-based solutions, local or regional or national stakeholders (depending on how specific the project is) must be involved and engaged (step 12), as they might deal with the problem(s) daily and be familiar with local demands. That is why it is important to identify the actors in a previous step (step 5).

The final step of **Phase 2** is to apply process-based indicators (step 13). These indicators will help monitor project activities and their direct results.

PHASE 3 – MONITORING AND EVALUATION

After designing and implementing nature-based solutions activities (**Phases 2**), comes the monitoring and evaluation phase. This is the third and final phase (**Phase 3**) of the framework. The monitoring can be done using result-based indicators (step 14) – those designed as the baseline (step 8) and applied during project implementation (step 13). These indicators will show how, or if, the project activities are achieving the previously defined target(s) (step 15) and sustainable development goals (step 16) in the medium and long term.

In nature-based solutions, creating, maintaining or improving co-benefits and well-being are desirable goals. The result-based indicators can help evaluate if they are being reached or generated in the long term (steps 17-18). If by the end of step 18 the answer is "No" for any of the steps 15-18, it is recommended re-evaluate and adjust actions (step 19). Where necessary one should return to the design phase (**Phase 2**).

Photo: Rebelo, Alanna / South Africa

PRACTICAL EXAMPLES OF HOW THE NATWiP FRAMEWORK HAS ALREADY BEEN APPLIED: NINE NATURE-BASED SOLUTIONS CASE STUDIES FROM AROUND THE WORLD

CHAPTER 4

The aim of this chapter is to demonstrate how the NATWiP Framework has been applied to nine case studies across the world (illustrated in **Figure 4)** as part of the NATWiP Project. Each study considered different nature-based solution types in specific phases of nature-based solution projects: research and planning (**Phase 1**); implementation (**Phase 2**); or, monitoring and evaluation (**Phase 3**).

Irrespective of whether you are just starting to plan a nature-based solution project, or designing one, whether you are currently implementing it and wish to monitor the process or results, or whether you have completed a project and would like to evaluate it, you may wish to have a look at the examples in this chapter to explore and understand how others have applied this flexible framework in real-life situations.

For an example of the NATWiP Framework see **Appendix 1**. Examples of indicators for a specific nature-based solution may be found in **Appendix 2**.

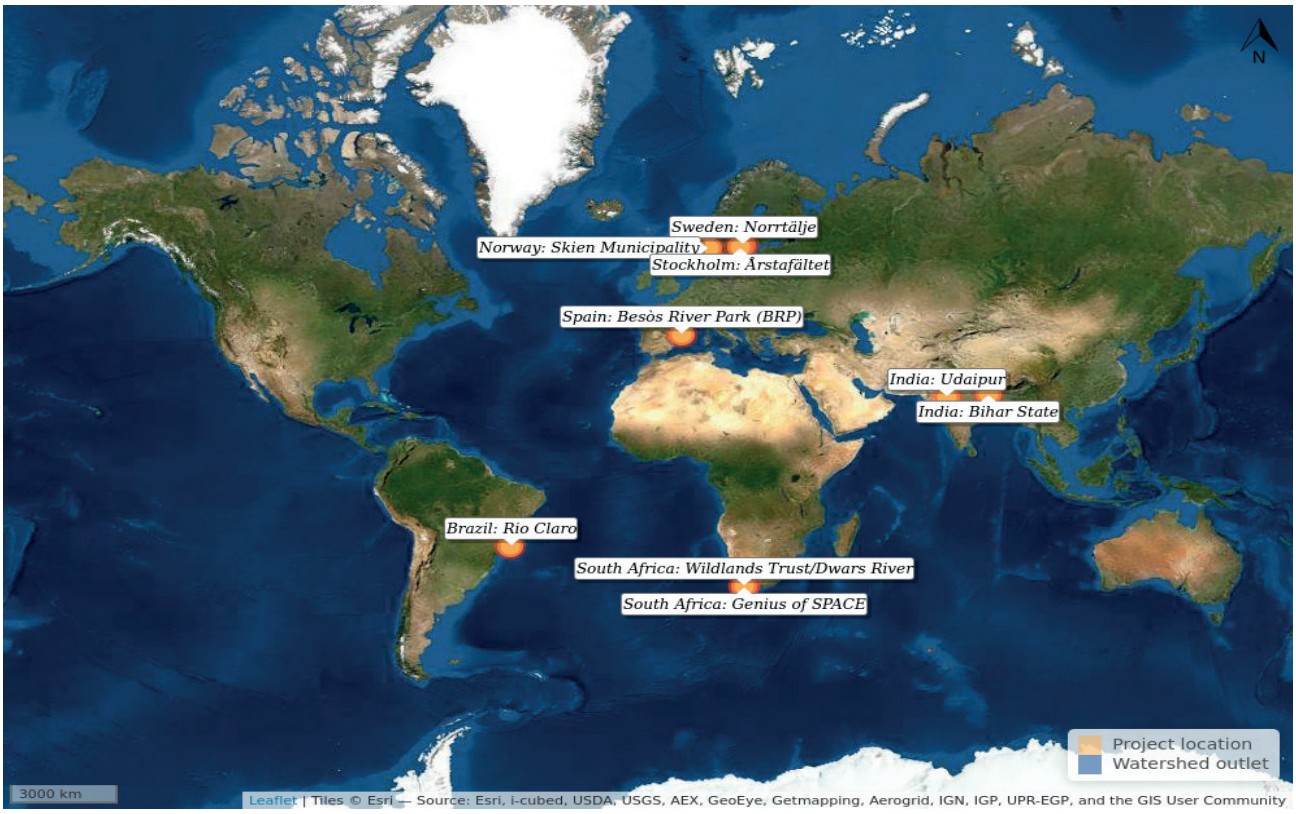


Figure 4. The nine nature-based solutions case studies from the NATWiP Project are spread across the world, with five in the Global South and four in the Global North. The map can be accessed and viewed with many different and relevant layers here: http://miljo.ngi.no/NATWiP/.

PHASE 1 – RESEARCH AND PLANNING

Skien Municipality case study, Norway (Box 1)

The Kjørbekk Stream in Norway was buried in the past and the area used as an unlined landfill. The reopening of this river, designed as a nature-based solution, is currently in the planning phase. This case study looks into how nature-based solutions can be used as part of the reopening strategy and play a catalytic role for city development.

In applying the NATWiP Framework to this case study, the 'context' feature was used to a large extent. The 'process' feature was partially used and the 'results' feature was not applied at all. The Norwegian stakeholder represented in this case study was very involved in the work and was able to support the data collection phase.

The context part of the framework was filled-in by drawing upon reports and publicly available databases (in Norwegian). Owing to the fact that this case study is in the planning phase (**Phase 1**), the actual intervention to be used at the site has not been

selected. As a result, the environmental information in the process part of the framework could not be collected. However, based on information that was gathered in discussions with the stakeholder, the process part of the framework – related to social governance – could be completed to a large degree and the sections related to economic and technical, to a lesser degree. The technical component refers to the specific nature-based solution intervention(s) that are planned within the project, such as those for remediating contaminated water or soil.

BOX 1

RE-OPENING A STREAM RUNNING OVER TWO BURIED LANDFILLS AT KJØRBEKK, NORWAY

In Skien Municipality, close to Oslo, Norway, nature-based solutions are being considered as part of the potential reopening of the Kjørbekk stream.

The Kjørbekk stream runs through terrain characterised by forest areas, farmland and industrial buildings. Topography varies from very steep to flat and the outlet of the Kjørbekk stream is the Skien River. The surrounding populace represent a middle-to-high income demographic and there are several national policies in place to protect water.

A 4km stretch of the Kjørbekk stream is contained in old pipe infrastructure that is buried under two disused landfills. The current pipeline does not have the physical capacity to cope with increased water volume (from precipitation accompanying current climate change). Also, there is concern that cracks may soon appear in certain sections of the pipeline. This means that surface water run off that cannot be accommodated by the pipe, as well as water that may potentially leak from it, can become contaminated by the waste in the landfills. Contaminated water can then be transported via the stream to the final outflow point.

The case study is currently in the planning phase and the municipality is considering various options whereby nature-based solutions can support the re-opening of the Kjørbekk Stream. The nature-based solutions under consideration focus on a) reducing the amount of water in contact with pollutants; b) reducing the amount of particle spreading; c) remediating contaminated water; and d) remediating contaminated soil.

Water can also be led away from the landfills and the amount of water flowing through the area can be reduced through landscape modelling. This will reduce the amount of water that may potentially be polluted.

In order to reduce both airborne and waterborne particle spread, a layer of natural vegetation or clean soil can be placed on top of the contaminated surface material. Constructed wetlands may also be considered. These are filtration systems with defined filter materials that are planted with wetland vegetation, resulting in a conducive local microbial and plant ecosystem. They can be used to remediate contaminated water. Contaminated soil could be remediated via other processes, such as aeration, natural degradation and monitored natural attenuation. Small amounts of biochar may also be mixed in to bind pollutants.

The outlet of the Kjørbekk Stream is the Skien River, Norway. The re-opening process must ensure that pollutants are not carried with moving water to the final outflow point.
Photo: Smebye, Andreas (Norwegian Geotechnical Institute)

Link to case study brief:
http://www.NATWiP.solutions/

PHASE 2 – IMPLEMENTATION

Norrtälje case study, Sweden (Box 2)

The case study in Norrtälje concerns nature-based solutions for greywater treatment. It can be considered to be in both the planning and implementation phases.

The nature-based solution is planned or implemented at a decentralised (household) scale with property owners driving their own projects in individual capacities or in collectives. An attempt was made in this study to understand the context of these decentralised projects together with the processes of planning and implementation.

Also, of interest was to explore the merits and drawbacks of the nature-based solutions options compared to the traditional infrastructure options available on the market, considering the three sustainability dimensions identified by the NATWiP Framework (environmental, social and economic). Thus, all three parts of the framework (context, process and results) were used to assess the nature-based solution in question. These were applied to a variety of nature-based solutions technologies available on the market and implemented at the household scale.

In order to apply the framework to the Norrtälje case study, the first step was to frame specific, indicator-based, research questions corresponding to the three parts of the framework. Thereafter, a combination of methods and data sources were used for obtaining answers.

For aspects related to policy and technology, secondary sources were explored first. At the same time, relevant stakeholders were identified for these (policy and technology) and other aspects, such as: governance; participation; information and education; and others. A survey was then administered and in-depth interviews conducted. The survey was mainly administered to the local property owners. The in-depth interviews were mainly conducted with other stakeholders, such as the municipality, private companies (producing nature-based solution technologies for greywater treatment), entrepreneurs (installing these technologies) and some selected property owners, or joint property associations.

Due to restrictions posed by Covid-19, the survey had to be designed as an online exercise, while interviews were mainly conducted telephonically. A detailed survey questionnaire and relevant interview guides were prepared for this purpose.

The collected data were classified according to the three parts of the framework: context, process and results. Then the data were analysed for reaching systematic conclusions and gaining an understanding of the major opportunities and barriers faced in using nature-based solutions for bridging the water cycle gap in peri-urban areas.

BOX 2

USING NATURE-BASED SOLUTIONS FOR GREYWATER TREATMENT IN THE SUMMER COTTAGES OF NORRTÄLJE, IN STOCKHOLM ARCHIPELAGO, SWEDEN

The Stockholm Archipelago is the second-largest archipelago in the Baltic Sea and a popular summer destination. Here, the Norrtälje Municipality has the largest number of summer cottages (13 900). Many of these cottages lie outside the reach of municipal water supply and sewerage. This poses challenges of access to safe water in adequate quantities for the inhabitants, while also contributing to eutrophication (excessive increase in nutrients and minerals) in of the Baltic Sea. The conversion of a large number of these houses into permanent residences further aggravates the problem.

Considering the goals set within the EU Water Framework Directive, the Baltic Sea Action Plan (at a regional scale) and under the United Nations 2030 Agenda for Sustainable Development Goals, it is desirable and imperative to implement solutions that can sustainably address the water cycle gap in this coastal municipality.

According to Swedish law and municipal regulations, property owners are financially and physically responsible for implementing efficient wastewater solutions in their summer cottages. A large variety of technological solutions exist in the market and, though not explicitly marketed as a category, many of these solutions can be described as 'nature-based.'

To install a nature-based solution (or other solution) for greywater treatment, the property owner has to first apply for approval from the municipality and then, with the help of an entrepreneur, plan and implement the project at the household scale. Alternatively, owners of a number of neighbouring cottages may decide to constitute a collective to implement the project, sharing all costs and responsibilities.

This case study aimed to gain an understanding of the major opportunities, barriers and benefits related to nature-based solutions as a means for greywater treatment at a decentralised scale. The results are based on an empirical study in Norrtälje Municipality that includes a literature review, survey and in-depth interviews with key stakeholders.

The nature-based solutions that already exist on the market for greywater treatment offer multiple benefits. On the environmental side, benefits include filtering out of harmful chemicals, microbes and, in some cases, even pharmaceutical residues. On the whole, these are eco-friendly solutions that promote water sustainability through multiple pathways at local as well as Baltic Sea Region scales. Economically speaking, the benefits promote cost savings, through improved water quality, and enables reuse of treated water. Property values may also increase as a result. On a social level, the benefits extend to maintaining physical and mental health (directly and indirectly), enhancing aesthetic and recreational values and empowering users, through the option of participation in sustainable environmental stewardship.

What emerges from this case study is that clear policy support for nature-based solutions for greywater treatment in Sweden does exist. Additionally, decentralized models for nature-based solutions implementation through direct citizen engagement has proven to be effective. However, there is a great need to enhance technical awareness and related education at all levels. Municipalities too need to adopt a more supportive role, facilitating citizen engagement. On the environmental side, the context-specific lesson is that nature-based solutions can provide more dynamic, multifunctional benefits (compared to conventional solutions). These benefits have a high potential for promoting water resilience in transitional coastal areas.

Greywater dam – a constructed wetland – where wastewater purification is based on green phytotechnology. The treatment takes place in three steps: first the sludge from the greywater is composted in a reed bed; next, the separated greywater is recycled by a pond with plants via a water ladder for oxygenation; and finally, the purified water is spread over a small gravel bed, or stone coffin, below the ground.

Photo: Ateljé AB's, Virbela. (website: https://www.virbela.se/aquairis)

Link to case study brief: http://www.NATWiP.solutions/

Årstafältet case study, Sweden (Box 3)

At the time of the NATWiP Project, the Årstafältet development project was spanning Phase 1 and Phase 2 of the NATWiP Framework: the research and planning phase; and the implementation phase.

The project designed very ambitious and diverse nature-based solutions, in terms of size and quality. The planning context of the development was studied, focusing on the planning and implementation of the nature-based solutions. The aim was to assess the benefits and co-benefits that planners and decision makers had anticipated (and designed the project for), in terms of the three sustainability dimensions identified by the NATWiP Framework.

The project leads also sought to understand the major barriers and challenges for putting in place sustainable nature-based solutions that fulfil these three dimensions. To achieve this, they studied the context of nature-based solutions projects, reflecting on the processes of planning and implementation and their dynamics. They then assessed the anticipated results. All three parts of the framework (context, process and results) were therefore utilised to assess the nature-based solutions.

However, the framework was adjusted to the specific context of the case study, in order to collect meaningful data and results. This was done by identifying key municipal, private and community actors involved in the planning and implementation of nature-based solutions. An interview schedule and a catalogue of semi-structured questions, applying the framework to assess the indicators identified, was developed.

Interviews were then conducted with identified actors. The semi-structured nature of the questions allowed participants to reflect, elaborate and express their views freely. These interviews were recorded for transcription purposes. The data that were collected were organised along context, process and results – the three parts of the NATWiP Framework – to allow for detailed assessment and cross-case comparison in the NATWiP Project.

BOX 3

PLANNING AND IMPLEMENTATION OF NATURE-BASED SOLUTIONS IN URBANISING PROJECT IN ÅRSTAFÄLTET, STOCKHOLM

Årstafältet is a large, open grass field located in a suburb in southern Stockholm, Sweden, where a nature-based solutions project is being planned. Under scrutiny in this NATWiP case study, the project initially included the construction of a water impoundment (area where water is artificially gathered, such as ponds) and streams. The aim of the project was to integrate these into a park to purifies runoff from the surroundings and to restore natural water flow. It was argued that this would maintain the ecological integrity of the landscape.

However, due to the huge housing demand in Stockholm, the city decided to urbanise the area. This would be done by constructing residential buildings and capitalising on existing nature-based solutions. The pond and stream would be enlarged and transformed into four ponds. Plans to redesign the city's storm water strategy placed pressure on project planners. Hence, the city decided to embark on an ambitious plan to broaden and diversify the intended nature-based solutions. Rainfall management parks, open ditches, trees planted along roads, an additional water pond, swales (shallow channels), allotment gardens and deciduous forests were extra options integrated in the project plan.

Nature-based solutions were generally intended to counteract the negative impacts of the desired urban development project. But, the planning and construction of the ponds has been greatly hampered. The challenges include: opposition and appeals by civic groups; technical uncertainties; high costs and over investment; roles of planners and designers being contested; financing issues; ownership; division of responsibilities for maintaining nature-based solutions; and the very dynamic and long-term planning process that is subject to contingencies and change.

This NATWiP study aims to gain a complex understanding of the policy and socio-economic context, the planning and implementation processes and results of the nature-based solutions in Årstafältet. Key actors involved in the planning and implementation processes were identified and interviewed. They stemmed from various city administrations (urban and landscape planners and designers), a state-owned company, consulting companies (landscape architects, planners, and water engineers) and civil organisations. The interviews followed a semi-structured (open-ended) questionnaire based on the NATWiP Framework. In addition, the policy and planning documents were analysed for validation of complementary data.

The nature-based solution related to the development project is in the implementation phase. This means that socio-economic and environmental impacts, as well as benefits, cannot be measured or assessed at this stage – they can only be anticipated.

Nature-based solutions are also perceived to be positioned in the public realm. Their designs allow for meeting places (public and safe spaces), co-living, social inclusiveness and cohesion, bridging vast socio-economic differences between implementation areas and their surrounding areas, and giving the area a unique cultural and environmental identity.

The City of Stockholm promotes a policy model that is responsive to different water-related pressures and supports nature-based solutions in various ways. However, regulations that define the organisations' and actors' interactions in the planning, water services and environmental objectives are not coherent or do not adequately support nature-based solutions. This is an issue that impacts the roles and structure, financing, division of responsibilities and ownership issues among actors and organisations. In turn, this can sometimes lead to positional tensions and compromise social and technical learning outcomes.

Freshwater ponds, stormwater parks, and more – nature-based solutions in urbanising Årstafältet in Stockholm.

Photo: Still image captured from the film *Dagvattnet på Årstafältet* (The Stormwater in Årstafältet), produced by Tema, on behalf of the City of Stockholm.

Link to case study brief:
http://www.NATWiP.solutions/

Bihar State case study, India (Box 4)

The nature-based solution project *Jal-Jeevan-Hariyali Mission* (translated as: Water-Life-Greenery), is a state-sponsored project in Bihar State. The project is currently in its implementation phase, having started in October 2019. It seeks to integrate traditional knowledge with modern techniques of environmental conservation and water management, so that the annual disasters of floods and droughts can be better managed.

The region under investigation suffers from constant water quantity and quality issues. It also experiences frequent floods and droughts. Socio-economic parameters of peri-urban communities were analysed in order to determine their role in the emerging results of this project.

The unique aspect of this case study has been the combination of traditional practices with innovative technological interventions by which issues of pollution/contamination of water resources, depletion of ground water, overuse of available water resources and water mismanagement (arising from lack of inter-sectoral coordination) are being addressed.

The scale of activity has been at the community level. Here top-down, as well as bottom-up, development approaches are being used cohesively for holistic water management projects observed in this NATWiP Project study area.

This case study sought to assess the sustainability of the *Jal-Jeevan-Hariyali Mission* (JJHM) project along environmental, social and economic dimensions, as per the NATWiP Framework. For carrying out the case study, secondary information and data sources were accessed. Interview schedules were prepared beforehand, based on the three parts of the framework. Thereafter, person-to-person and telephonic interviews were carried out with policy makers, implementers at central and local levels and an active non-governmental organisation.

Finally, interviews with identified intermediaries and beneficiaries at community-level were conducted, limited by Covid-19-related mobility restrictions. Likewise, field visits to assess nature-based solutions implementation, as well as administrative and community responses were limited.

BOX 4

THE JAL-JEEVAN-HARIYALI MISSION PROMOTES INTEGRATED DEVELOPMENT IN PERI-URBAN BIHAR STATE, INDIA

The ***Jal-Jeevan-Hariyali Mission*** (translated as: Water-Life-Greenery) project was launched in 2019 in the state of Bihar, India. The region under study faces the problem of water quantity (due to floods and droughts) and water quality. This project deals with issues of pollution and contamination of water resources, depletion of groundwater, overuse of available water resources and water mismanagement arising from lack of inter-sectoral coordination.

The objective of this nature-based solution is the revival of 'human-nature synergy'. This is achieved through an integrated ecosystem approach, traditional water conservation methods, restoration of surface water bodies and by increasing green cover. Seven primary actions are involved in this process: 1) identifying and mapping old water bodies; 2) removal of encroachment and restoration of identified water bodies; 3) renovation and rejuvenation of all water bodies; 4) tree planting that suits local needs, as well as along water bodies, to prevent soil erosion and maintain the local hydrological cycle; 5) engaging communities through local decision-making and by generating employment schemes; 6) better project management through increased participation of women; and 7) regular awareness campaigns.

The aim of this study was to assess the implementation of the *Jal-Jeevan-Hariyali Mission* (JJHM) project. For this purpose, interview schedules were prepared and responses obtained from the three stakeholder groups, namely: the decision-makers or administrators; Non-Governmental Organisations; and the beneficiaries or concerned community members.

The benefits were summarised into the three sustainability dimensions (environmental, social and economic). Environmental benefits include restoration of ecosystems; increases in the number of surface water resources and soil moisture; shifts from mono- to multi-cropping systems; tree planting activities leading to soil conservation; and reduction of heat waves, due to increased moisture levels of the air.

Social benefits observed are increased community participation in project implantation and decision-making processes; increased community ownership of assets generated; reduced migration from peri-urban areas; and increase in dependency on agriculture.

In terms of economic benefits, there has been an increase in agricultural production, implying improved income and also job creation. Increases in ground water tables and mitigation of water stress for agriculture and irrigation activities have also been noted. The assets created will benefit the peri-urban communities.

A noteworthy fact is that this nature-based solutions project has catalysed a convergence, for the first time, of twelve departments of the Government of Bihar State. As a result, these administrators now have a common resolve to address climate change issues. Community related work needs dedicated teams and specialised human resources. Finally, operation and maintenance of assets created under this project is a major constraint.

A water channel (also referred to as 'pyne'), renovated under the JJHM project, supplying irrigation water to agricultural fields in peri-urban Patna, Bihar State, India.

Photo: Department of Rural Development, Government of Bihar, India

Link to case study brief:
http://www.NATWiP.solutions/

PHASE 3 – MONITORING AND EVALUATION

Stellenbosch case studies, South Africa (Box 5 & Box 6)

An alien tree clearing project (Box 5) has been running for years and is still on-going; and a green infrastructure project (Box 6) has been completed. The aim of this project was research-related: the project leads wanted to assess the two projects in terms of the benefits and co-benefits they produced, in terms of all three of the NATWiP Framework sustainability dimensions.

There was also a need to understand the major barriers and challenges to these projects (in terms of these three dimensions), as well as the contexts that would be most favourable for the projects to operate under. This required a holistic approach, understanding the context, reflecting on the process of implementation and assessing the results. Therefore, all three parts of the framework were used (context, process and results) to assess the nature-based solutions (**Appendix 2**).

The same approach was used for both case studies. Perceptions of community members, both those directly involved in the nature-based solutions and those not involved, as well as implementers were collected. A semi-structured interview schedule, using the NATWiP Framework, was developed to allow assessment using indicators from each of the three sustainability dimensions under each of the three project phases. The community interview was slightly different from the implementer interview. The former focussed more heavily on context and results, whereas the latter focussed on the process in more detail.

Interviews were conducted in each of the respective communities. The aim was to get a sample size of at least 20 community members and 10 implementers, taking into account potential biases and making sure to get a diverse representation. Feedback for specific interview questions were captured in a database and all interviews were recorded for transcription. The interviews were conducted in the native language of the interviewees: isiXhosa, Afrikaans or English.

Data were then analysed to understand major barriers or challenges, favourable contexts and key results of the nature-based solutions (benefits, co-benefits and other impacts; **Appendix 2**). Using the holistic framework enabled the project leads to assess every aspect of the project and ensured that no phase or dimension was excluded.

BOX 5

ALIEN TREE CLEARING TO IMPROVE WATER SECURITY IN THE DWARS RIVER, SOUTH AFRICA

The Wildlands Trust has been coordinating several riparian rehabilitation projects since 2018 along the Dwars River, a tributary of the Berg River in the Western Cape, South Africa.

The Dwars River is heavily transformed, with landcover converted to predominantly agriculture over the past 300 years (mainly viticulture and fruit). An inter-basin transfer out of the Dwars River catchment affects the hydrological regime. The agricultural disturbances and the transfer of water away from the river, among other factors, result in infestation of the riparian zone by invasive alien trees and weeds.

These invasive alien trees consume high volumes of water, reducing water supply, increasing fire risk, and negatively impacting biodiversity. The nature-based solution implemented by Wildlands Trust involves three approaches: 1) the clearing of invasive alien trees, shrubs and weeds from the riparian zone (initially through logging operations, with follow-up clearing); 2) active rehabilitation of the riparian zone, through the planting of indigenous tree seedlings; and 3) engaging the community by creating employment opportunities in the rehabilitation programme, as well as recycling and native tree growing programmes, aimed to keep the river clean, in exchange for rewards (e.g. bicycles).

This nature-based solution takes the form of a socio-ecological systems approach. It aims to improve hydrological flows (increase water availability), engage the community and indirectly – if implemented at scale – may improve water quality (dilution effects). The scale of the implementation is currently relatively small (small sections or strips of riparian zone along the river). Therefore, the benefits of these interventions are mainly local and difficult to quantify.

Workers, community members and implementers were interviewed using semi-structured surveys to answer questions about the context, process and results of this nature-based solution. The nature-based solution appears to have been welcomed by the community and good communication is cited as a key factor in having achieved this.

Many community members perceived improvements to nature (improvements in ecosystem services). Improvements are experienced as recreational benefits, improvements to aesthetics, general well-being, social cohesion and nature-connectedness. Many also felt that the nature-based solution changed how nature was used for recreation, how it improved the community's connection to nature, how it enhanced community health and well-being, and how it promoted social cohesion.

Any benefits, in terms of increased water supply or improved water quality, though perhaps small due to the scale of the work, would be beneficial to farmers downstream who rely on the Dwars River or Berg River (downstream from the Dwars River) for irrigation.

According to implementers, major challenges include: sustainable and sufficient funding; silo-mentalities in government; multi-level collaboration; socially vulnerable communities; and the value of the river (both in terms of its inherent and economic value) not being recognised. The main issue raised by the community was that of job creation for more people through the project. Interestingly, communication was also raised as an area that could be improved through better and multi-phased community engagement.

Working for Water teams (operating under the implementing agent: Wildlands Trust) clear foliage, after logging operations, of mature alien trees (mainly Black Alder) that had invaded the riparian zone of the Dwars River, South Africa.

Photo: Van Rooyen, Lydia (Wildlands Trust)

Link to case study brief:
http://www.NATWiP.solutions/

BOX 6

GREEN INFRASTRUCTURE TO IMPROVE WASTEWATER MANAGEMENT IN AN INFORMAL SETTLEMENT IN LANGRUG, SOUTH AFRICA

Langrug is a relatively recently formed, and continuously expanding, informal settlement (slum) near Franschhoek, South Africa. Wastewater and solid waste accumulate in its streets, due to lack of service provision and sewerage. Surface hardening contributes to localised flooding. These factors combined increases risk of disease and other associated health issues.

The Stiebeuel River drains the Langrug Catchment (about 4.37 km^2) and enters the Berg River. The Berg River, in turn, is an important agricultural (predominantly winter wheat, vineyards and fruit) river for the Western Cape that eventually enters the sea at the Velddrif Estuary (St Helena Bay), supporting important fisheries. Eutrophication and pollution of the Berg River causes severe issues for agriculture downstream. This is particularly problematic, as water quality may fall short of stringent growing and import standards required by overseas trading partners.

The Genius of SPACE (Systems for People's Access to a Clean Environment) pilot project applied nature-based solutions with the following aims in mind: 1) treat and manage wastewater and greywater entering the stormwater system; 2) manage solid waste; 3) empower local community members; 4) improve living conditions and promote social upliftment.

The nature-based solution involved installation of 27 greywater disposal points, inserting underground wastewater pipes, laying permeable paving, road grading, pavement construction and establishing 15 tree gardens for water infiltration.

Workers, community members and implementers were interviewed using semi-structured surveys to answer questions around the context, process and results of this nature-based solution. Key challenges cited by implementers included: complex social and institutional issues; challenges around cooperative governance; communication and integration of efforts between community and local government; social imbalances; stakeholder support; rapid urbanisation; and budget limitations (unsustainable and insufficient funding).

Major challenges cited by the community included: members who would not listen to advice or recommendations; vandalism; bad communication; lack of collaboration; and a widespread feeling that the budget could have been better spent. An overwhelming desire was expressed that this pilot project be upscaled to the whole community.

Due to the challenges mentioned above, the implementers considered the nature-based solution pilot a failed project. Consequently, the second phase of the project – which was geared towards generating income in return for maintaining service provision – never materialised. Nevertheless, the nature-based solutions provided the community great benefits in terms of ecosystem service provision, social cohesion, nature-connectedness, gender equality, and health and well-being.

Community members became more aware of what happened to wastewater (pointing to an educational result) and noted that water became more available for other uses through the nature-based solution. They also inferred that the project be reinitiated. The Implementers felt that the community participated well in the project.

Permeable paving constructed between homes in the informal settlement of Langrug, near Franschhoek, South Africa. Surface hardening leading to poor infiltration, coupled with poor water management systems resulted in wastewater and sewage flowing through the streets. This was addressed with an integrated green and grey infrastructure approach: a combination of permeable pavements, wastewater deposit points and insertion of pipelines.
Photo: Kritzinger, Dandi.
Link to case study brief:
http://www.NATWiP.solutions/

Besòs River Park case study, Spain (Box 7)

The river restoration project in Catalonia, Spain was developed two decades ago. It served as a strategy to overcome issues related to water quality and quantity, while also providing a spatial response to a peri-urban area of metropolitan motorways.

To develop a comprehensive understanding of the case study, the NATWiP Framework was applied. Data were gathered from a variety of sources, including academic literature, policy instruments, direct observation, and interviews with various stakeholders. Additionally, perspectives from citizens were incorporated into the assessment, as they are the primary beneficiaries of the nature-based solution.

Consequently, a survey campaign was conducted in June 2021. This was intended to gain insight into the public opinion on the services and benefits of this nature-based solution, complementing the ongoing research.

BOX 7

THE BESÒS RIVER RESTORATION PROJECT, BARCELONA METROPOLITAN AREA, SPAIN

This nature-based project was initiated in response to poor water quality (and general degradation) in the Besòs River. Industrial pollution and waste was seen as the cause of water quality issues. Furthermore, freshwater extraction resulted in low flows. The river system also experiences flooding, due to heavy rainfall events. The surrounding Metropolitan area has a higher concentration of socially vulnerable inhabitants, of a much lower income bracket, compared to Barcelona city.

These concerns were addressed by a large-scale river restoration project that began in 1996. The project served to improve the environmental conditions of the riverbed, particularly its water quality and hydraulic capacity. It also aimed to open up the river's banks for passive recreational activities compatible with appropriate risk management.

The restoration project included two nature-based solutions types. The first was constructed wetlands, which treats the lower river basin biologically, removing phosphorus through natural depuration. The second was a 22-hectare (9km long) riverside park that blends urban and natural landscapes as a mix of blue (water-related) and green (ecological) infrastructure.

Today, the added value of the nature-based solutions stems from the landscape's high degree of multifunctional use that benefits nearly 1 million visitors each year. It provides opportunities for relaxation (to improve physical health) and gatherings (enhancing social cohesion) in natural spaces.

The section of the Besòs River being studied is considered a strategic area for the metropolitan water cycle. On a policy level, this overlaps with the Metropolitan City's green and blue infrastructure goals. However, an ongoing challenge is that the shared management of the nature-based solutions does not allow for maintenance of the constructed wetlands or the multifunctional landscape of the riverside park.

To address this, two critical entities have proven to be helpful: 1) the Consortium Besòs – a cross-border organisation coordinating daily activities for nature-based solutions maintenance; and 2) the Agenda Besòs – a strategic policy instrument for overarching consensus on shared leadership and integration of municipalities, sectors and decision-makers.

Besòs River Park in the Barcelona Metropolitan Area.
Photo: UPC Barcelona Tech, Institute for Sustainability Sciences and Technology – Lesec research group
https://lesec.upc.edu/en
Link to case study brief: http://www.NATWiP.solutions/

Udaipur case study, India (Box 8)

This case study concerns a unique lake system situated in the semi-arid, western state of Rajasthan, in and around the historic city of Udaipur.

In the process of applying the NATWiP Framework to the case study, the first step was to formulate specific indicator-based research questions that correspond to the three parts of the framework (context, process and results). Thereafter, both primary and secondary data sources were used for obtaining answers.

Since the project objectives and indicators required a study of the past, a review of relevant literature was carried out first. An effort was made, at the same time, to identify key local informants who possess in-depth knowledge about the lake system, its maintenance and current challenges. This was followed by a field trip to Udaipur where the network of lakes was visited to understand how it functions and what its impacts are.

Some of the informants identified earlier were contacted; and interviews and group discussions were organised during the trip. The informants included members of the local Lake Protection Group, relevant government officials and citizen-activists. Members of local communities near the lakes who could be either beneficiaries or affected by lake degradation, or shared concern about its upkeep and maintenance, were also included among informants.

The interviews were mainly semi-structured in nature, using open-ended questions. Since Covid-19 prevented further field trips, continuous online contact was maintained with some of the local informants. Thereby, additional data were acquired where needed and where possible. In order to find answers to the research questions, the collected data were arranged along the three dimensions of the NATWiP Framework (context, process and results) and analysed.

BOX 8

THE UDAIPUR LAKE SYSTEM IN RAJASTHAN, INDIA: AN INTEGRATED NATURE-BASED SOLUTION FOR WATER SUSTAINABILITY CONNECTING URBAN AND PERI-URBAN SPACES

This case study concerns a unique lake system situated in the semi-arid western state of Rajasthan, India in the historic city of Udaipur. It has heritage value, in the form of an integrated nature-based solution for water sustainability in and around the city that was created over 400 years ago, which connects the city's urban and peri-urban spaces.

This network of lakes functions at a catchment scale, namely the Berach River Basin. It was created to support and sustain water availability in Udaipur, as the city is situated in a valley in the Aravalli Ranges that does not have access to any perennial river. The network has supported a range of cultural services through the ages (including tourism). It has also sustained groundwater recharge and made water available for drinking, agriculture and other livelihoods. The water cycle gap is addressed through rainwater harvesting and collection of the runoff in the interconnected lake system.

The network constitutes 100 big and small, public and private, artificial (man-made) lakes. Of these, 10 are large and critical for the system to function. The latter are categorised as follows: Upper lakes (3), City Lakes (6) and Downstream Lake (1). Historically, the larger lakes were mainly created and maintained under royal patronage. Today they are governed by the Rajasthan State government and the local municipality.

The two aims of this study are 1) to analyse the historical factors underlying the sustainability of the Udaipur Lake system – considered along the three dimensions of sustainability (environmental, social and economic); and 2) to identify the challenges that are increasingly threatening its sustainability in recent times. The ultimate purpose is to propose alternative polices and action-plans to remedy the situation and promote water sustainability in this semi-arid region. For this purpose, all the three parts of the NATWiP Framework (context, process and results) were used to assess the nature-based solution in question. Data were collected through observation, interviews and group discussions with key stakeholders and other local actors.

The most important lessons emerging from the study are as follows. Firstly, rainwater harvesting and collection of local runoff is an important nature-based solution that may potentially fulfil the water needs of urban centres, as well as peri-urban spaces in surrounding areas. The second lesson is integration of local knowledge for protection, upkeep and maintenance of the biophysical components of the system is essential to ensure that it continues to deliver the benefits. Thirdly, resolving conflicts between different stakeholder interests, in favour of environmental interests, is essential for keeping the lake system alive. And finally, engaging local citizens has a strong positive impact on efficient governance of the lakes.

Badi Lake or Jayana Sagar – one of the Upper lakes in peri-urban Udaipur, India, with a depth of 29 feet. It collects runoff from the surrounding Aravalli Hills and acts as a buffer water reserve for the city, supplying drinking water in times of emergency. Otherwise, it supplies water for irrigation in neighbouring villages, and its overflow feeds Fateh Sagar Lake in the city.

Photo: Singh, Om Prakash.

Link to case study brief: http://www.NATWiP.solutions/

Rio Claro case study, Brazil (Box 9)

The *Water and Forest Producers Project* in Rio Claro was implemented in 2009, aiming to improve the quality and quantity of water in a stretch of the Guandu River basin. The river basin is located in a peri-urban area and is a vital source of drinking water for 12 million people in the metropolitan region of Rio de Janeiro.

The nature-based solution implemented in this study case was restoration. Payment mechanisms for environmental services were developed to encourage property owners to adhere to the project.

The project is currently in the monitoring and evaluation phase. Data were obtained through meetings with *The Nature Conservancy* (TNC) project implementers who are currently working on program monitoring and evaluation to understand the project progress. In addition, various reports and academic literature was consulted.

BOX 9

FOREST RESTORATION IN BRAZIL

Rio Claro, Rio de Janeiro State, Brazil, is located in the Guandu River basin. This municipality is located in a strategic area for water supply in Rio de Janeiro and is currently a vital source of drinking water for 12 million people in the Rio de Janeiro Metropolitan region.

The Rio Claro region is notorious for its historic deforestation of the Atlantic Forest biome at the end of the nineteenth and beginning of the twentieth century due to increased coffee production. Created as a tool for environmental management, the *Water and Forest Producers Project* was implemented in 2009 (and active until 2021) in the municipality of Rio Claro.

One of the significant challenges for conserving and restoring the Atlantic Forest in Brazil is that over half (53%) of its surviving remnants occur on private rural properties, hindering the restoration process. The program overcame this difficulty by financially compensating local landowners for maintaining ecosystem services on their land, conserving over 4000 hectares and restoring 500 hectares of Atlantic Forest in the Guandu River basin in the process. The program saw several governmental and nongovernmental institutions working together and can be considered an example of shared management of natural resources.

In terms of governance at the local level, the Guandu Watershed Committee deliberates on actions and projects, and provides the financial resources for payments. The Nature Conservancy monitors the project and pays for monitoring-related expenses. The Water Management Association of the Paraiba do Sul River Basin executes the actions deliberated by the Committee; and, lastly, at the municipal level, the city hall of Rio Claro receives the financial resources from the Committee and makes the payments. The challenge is to grow partnership with more institutions that can help with funding, provide technical expertise and project outreach.

The nature-based solutions used in the program were two-fold: forest conservation and restoration; and payment for ecosystem services to improve water quality and quantity in the basin.

In order to assess this program using the NATWiP Framework, interviews and meetings were conducted with the project implementers from The Nature Conservancy who are currently working on the program monitoring and evaluation. In addition, reports and academic literature were consulted. Current results (for 2020) indicate increased involvement of the Quilombola Community (African slave descendants) in the program activities; an increase in biodiversity in the restored areas, with 63 bird species (a 91% increase compared to 2013); and incentives for bird-watching activities within the reserved areas.

Overall, the program improves the income of many rural landowners. The main lessons learned from this program include: 1) monitoring – to assess the effectiveness of the interventions; 2) community engagement – to attract more landowners and scale up activities; 3) social and environmental education – to raise awareness about the multiple benefits of having forest on private land; and 4) economic incentives – as further encouragement and support to change local perceptions regarding environmental degradation and, ultimately, scale up activities.

Riparian forest restoration at Papudos River (left), and preparation for forest restoration (right) in Brazil. Photo: Hendrik Lucchesi Mansur

Link to case study brief:
http://www.NATWiP.solutions/

Photo: Esler, Karen / Berg River

LESSONS FROM APPLYING THE NATWiP FRAMEWORK TO THE NATURE-BASED SOLUTIONS CASE STUDIES AND LINKS TO BEST PRACTICE

CHAPTER 5

The purpose of this chapter is, firstly, to emphasise lessons learnt from the case studies described in Chapter 4. A reflection is then provided on the opportunities and constraints highlighted within the unique context of each case study, especially those that overlap between various case studies. Finally, we link lessons learnt to best practices that may guide handbook users to pursue successful nature-based solutions interventions.

The nature-based solutions case studies described in Chapter 4 are all rich and diverse and hold educational value. Some of the lessons are common to several case studies and some are unique to a particular site. What is clear is that the context of a case study is very important when considering best practice. Best practice in one geographical area may not hold relevance to another geographical area. Likewise, best practice for one type of nature-based solution, may not be applicable to another. Thus, while the intention is that the NATWiP Handbook describes main lessons learnt, these are still quite broad and general, given the complexity and diversity of the case studies.

LESSONS LEARNT

The three pillars of sustainability and the NATWiP Framework phases (described in Chapter 2) served as a guide for ordering the lessons learnt. These can be found in **Table 1.**

Some of the lessons learnt are highly case specific (e.g. the importance of finding a champion and giving them a central role in implementation – specific to the Dwars River case study, South Africa),

Other lessons are more universal. One such lesson is the importance of education around nature and nature-based solutions. This could include education about how natural systems work (e.g. ecological functions) and their value to society, as well as about nature-based solutions in general and how they should be implemented. For implementers, specifically, training may be required on how to ensure that all stakeholders involved in an intervention are included.

The second universal lesson learnt is the importance of establishing multi-level collaboration and engagement at levels of government, and with all stakeholders, from the start of the project. This may also be a skill that potential implementers of nature-based solutions wish to seek training in before embarking on a project.

A third universally applicable lesson learnt is that context is important. Nature-based solution projects designed in one context, for a specific purpose, could not easily be transferred to another location (e.g. see debate on indiscriminate tree planting; Slingsby 2020, Forest restoration or propaganda?). Rather, nature-based solutions should be designed in order to match the local environmental and social contexts.

A fourth and final universal lesson is to promote positive results, as they will encourage the implementation of more nature-based solutions, potentially attract the interest of new investors and enforce a positive feedback loop. There are many more context-specific lessons learnt that may be valuable to potential implementers working within their own unique contexts.

Table 1. Lessons learnt from each of the nature-based solutions (NbS) case studies (where relevant, indicated in colour) organised using the NATWiP Framework (context, process and results) for each of the three sustainability dimensions.

	Context	Process	Results
Ecological	• Education on ecological principles and the value of nature Dwars, South Africa Brazil • Design the NbS to match the ecological context and expectation(s) All Case Studies	• It is important to couple alien plant clearing with active restoration at scale (holistic approach to the NbS) Dwars, South Africa • Educate the right people to carry out the NbS Genius, South Africa • Education and communication on the potential ecological benefits that can be achieved from the implementation of the proposed NbS Norway • Understanding and informing about the link between tree planting along water bodies to prevent soil erosion and maintenance of the local hydrological cycle JJHM, India	• Education and communication of the ecological benefits achieved by the NbS All Case Studies • Include a monitoring aspect to assess the environmental effectiveness of interventions and adjust if necessary Genius, South Africa Dwars, South Africa • Promote demonstrations of the success of the NbS Brazil
Social/ Governance	• Develop a supportive policy framework Norrtälje, Sweden Årstafältet, Sweden Norway Spain • Establish multi-level collaboration and engagement with at all stakeholder levels, from the start of the project (strengthen relationship with landowners, policy-makers etc.) All Case Studies • Promote education related to perception, practices, behaviours and attitudes towards NbS All Case Studies • Identify, develop and promote NbS heritage or local knowledge (if present) Udaipur, India JJHM, India	• Budget sufficient funding for stakeholder engagement Dwars, South Africa Norway Spain • Find a champion and give them a central role in implementation Dwars, South Africa • Manage expectations of stakeholders (e.g. long-term benefits of NbS versus desire for rapid change – the steep learning curve) Dwars, South Africa Genius, South Africa • Adopt a co-creation, co-design approach Genius, South Africa • Take cultural/societal values into consideration Genius, South Africa Udaipur, India JJHM, India • Adopt a clear coordination/implementation set-up Spain • Support good project management with sufficient training and participation at all stakeholder levels JJHM, India • Carry out awareness campaigns on a regular basis JJHM, India • Educate those involved about the NbS and its implementation Norrtälje, Sweden	• Promote positive results as they will encourage the implementation of more NbS and enforce a positive cycle All Case Studies
Economic	• Investigate diverse funding sources and build flexible funding models for NbS (ensure funds for stakeholder engagement) Dwars, South Africa Genius, South Africa JJHM, India Norway	• Link economic feasibility to social improvements Spain • Link economic benefits (such as: possible increase in property value; the ability for the landscape to adapt to climate change) to NbS implementation Norrtälje, Sweden Norway	• Promote economic feasibility and benefits achieved, in order to enforce positive financing Dwars, South Africa Norway

Key universal lessons learnt – how to implement successful nature-based solutions

1. **Education**. Environmental education and education on the value of nature-based solutions.
2. **Cooperation**. Establishing multi-level collaboration and engagement.
3. **Context**. Nature-based solutions should be designed to match their environmental and social contexts.
4. **Promotion**. Positive results should be promoted.

OPPORTUNITIES AND CONSTRAINTS

Of the many opportunities and constraints identified in the case studies (**Table 2**), not all necessarily translate to lessons learnt. These are factors to be aware of, and to look out for, as they can seriously jeopardise the potential success of a nature-based solutions project. They are mainly related to socio-economic or governance issues. Interesting to note is that there are generally more constraints listed by the Global South nature-based solutions case studies, but more opportunities expressed in the Global North case studies (with the exception of JJHM, India).

Table 2. Opportunities and Constraints, listed by the nature-based solutions (NbS) case studies

Constraints	Opportunities
• Institutional fragmentation (especially within government) Dwars, South Africa	• Funds and resources for the operation and maintenance of NbS created JJHM, India
• Unsustainable and insufficient funding Norway Dwars, South Africa Genius, South Africa	• Reduced migration away from peri-urban areas and increasing dependence on agriculture JJHM, India
• Socially vulnerable communities Dwars, South Africa	• Supporting policy framework Norrtälje, Sweden
• Power struggles between groups; and inequities Genius, South Africa JJHM, India	• Technology that is easy to install Norrtälje, Sweden
• NbS are expensive, requiring community investment Norrtälje, Sweden	• People are closely connected to regulating and provisioning ecosystem services Norrtälje, Sweden
	• Landowners and business owners affected by the NbS (positive and negative) Norway

PRINCIPLES FOR BEST PRACTICE

It is clear that holism, inclusion and education are reoccurring themes that can be considered alongside others to characterise best practice for nature-based solutions. The lessons learned while applying the NATWiP Framework to different case studies across the world point towards seven core principles that can promote sustainable nature-based solutions projects. Following is a summary of these principles.

Principle 1: Holism

Aristotle famously summarised the principle of holism as "the whole is more than the sum of its parts", highlighting the importance of collaboration. The design, implementation and monitoring of nature-based solutions is a long and complex process. It relies on experts with different backgrounds, as well as on practitioners, working together on all levels. Holism is a thread that runs through all phases and stages of a nature-based solutions project. Regardless of where one finds oneself in the cycle of a project, the interconnectedness of environmental, social and economic dimensions of sustainability must always be respected.

Principle 2: Context

A nature-based solution project should always be rooted in the local environmental, socio-political and economic context where it is proposed or implemented. The NATWiP Framework is an effective tool to consider these contexts and may be applied to analyse the linkages of the project, irrespective of its current stage or phase.

Principle 3: Technological simplicity and appropriateness

The technological intervention should be simple and ecologically appropriate so as to reinforce the natural resources base.

Principle 4: Multi-level stakeholder engagement

Nature-based solution projects require the engagement of diverse stakeholders at multiple (if not all) levels. Mechanisms should therefore be created to identify all stakeholders. It is vitally important to understand their interests and to involve them at appropriate project stages and phases. Their roles and responsibilities should be defined clearly. Power struggles and other kinds of inequalities must be addressed and, where possible, resolved in order to maximise collaboration.

Principle 5: Seek financial support for all project phases

To be sustainable, all project activities must be organised efficiently, whether for research and planning (**Phase 1**), implementation (**Phase 2**), or monitoring and evaluation (**Phase 3)** purposes. Availability of adequate funds and resources should enable this process. It is highly beneficial to secure sustainable funding for all project phases. Creative mechanisms, such as blended finance models, could be explored in this regard.

Principle 6: Education about nature-based solutions

The value of discussion, as well as of conveying of ideas and outcomes, is clearly demonstrated during the context, process and results phase of the case studies. This points to the fact that education for all stakeholder levels, during the entire process, is extremely important.

Before implementing nature-based solutions interventions, education is necessary to understand the current state of the system. Education throughout the application of the intervention can be used to inform different groups about the actual nature-based solutions, as well as to establish expectations. At the completion of the intervention, successful outcomes should be profiled and promoted in order to reinforce a positive nature-based solution cycle.

The sustainability of nature-based solution projects depends heavily on stakeholders' awareness of, and sensitivity towards, the value of nature and the related solutions. Hence, education focussing on these aspects must be designed and organised throughout the different stages and phases of the project. It also needs to be directed at the necessary or appropriate groups.

Principle 7: Adequate monitoring and evaluation

One aspect that could be considered a universal best practice, is the monitoring and evaluation of a nature-based solutions project through all its phases. Monitoring and evaluation is compatible with the principles of adaptive management. Here, a project may be adjusted as needed to ensure its sustainability and effectiveness throughout the project cycle.

Borrowing from principles and benchmarks of the field of ecological restoration, adaptive management using a holistic framework, such as the NATWiP Framework, could help to ensure long-term sustainability of nature-based solutions projects in a changing world.

Photo: Borba, Jonathan / Unsplash

CONCLUSION

CHAPTER 6

The overarching message of this handbook is that nature-based solutions provide a valuable solution to critical water-related challenges in peri-urban areas. The NATWiP Framework, in particular, is a state-of-the-art tool because it may be used to plan or design a nature-based solution, to implement it, or to monitor and evaluate it. All the while the three dimensions of sustainability (environment, social and economic) are considered.

The NATWiP Handbook describes the framework, explains how to apply it and showcases nine international case studies – in various phases of implementation – that have applied this framework in diverse ways. The case studies demonstrate lessons learnt, opportunities and constraints for nature-based solutions and some tips for best practice.

A crucial insight is that nature-based solutions often reap multiple co-benefits alongside primary (or key) benefits, but often over long timeframes. This is often at odds with society's desire for rapid change or immediate solutions. Evidently, there is a need to sensitively manage the public's (representing the full spectrum of potential stakeholders) diverse expectations. This requires careful communication – perhaps through strategic channels, such as public relations and educational campaigns.

These temporal scales need to be considered when deliberating nature-based solutions. For example, compared to grey infrastructure, which offers quick solutions, nature-based solutions rewards may generally take longer to be realised. But, this means they often also last longer, yielding multiple co-benefits far into the future.

Against a backdrop of anthropogenic climate change and the need for nations to adapt and mitigate against it, nature-based solutions offer an attractive and sensible way forward. If they are to be truly sustainable, however, careful thought needs to go into their design, implementation and monitoring and evaluation. The purpose behind the NATWiP Handbook is that it contributes to achieving more sustainable nature-based solutions for water management in peri-urban areas, and elsewhere, in the future.

SUGGESTED FURTHER READING

Bauduceau, N., Berry, P., Cecchi, C., Elmqvist, T., Fernández, M., Hartig, T., Krull, W., Mayerhofer, E., Sandra, N., Noring, L., Raskin-Delisle, K., Roozen, E., Sutherland, W., & Tack, J. (2015). Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & Re-Naturing Cities: Final Report of the Horizon 2020 Expert Group on Nature-Based Solutions and Re-Naturing Cities. 76. https://doi.org/10.2777/765301

Cohen-Shacham, E., Walters, G., Janzen, C., Maginnis, S., & (eds.). (2016). Nature-based Solutions to address global societal challenges: Vol. xiii. https://doi.org/10.2305/IUCN.CH.2016.13.en

IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN (First edition). Available here: https://www.iucn.org/theme/nature-based-solutions/resources/iucn-global-standard-nbs

JNCC (2021). Nature-based Solutions Triple Win Toolkit – International Climate Finance Evidence Project. JNCC, Peterborough. https://hub.jncc.gov.uk/assets/376d989f-0563-4e7f-b034-c79108f63758

Lima, A.P.M., Rodrigues, A.F., Latawiec, A.E., Dib, V., Gomes, F. Maioli, V. Pena, I. Tubenclack, F., Oen, A.M.P, Rebelo, A. J. Esler, K.J., Agudelo, A.R., Bosch, E.R., Singh, N. Suleiman, L. Hale, S.E. (2022). Framework for planning and evaluation of nature-based solutions.

Ramírez-Agudelo, N. A., Porcar Anento, R., Villares, M., & Roca, E. (2020). Nature-Based Solutions for Water Management in Peri-Urban Areas: Barriers and Lessons Learned from Implementation Experiences. Sustainability, 12(23), 9799. https://doi.org/10.3390/su12239799

APPENDICES

APPENDIX 1

The NATWiP Framework Template (Excel file including Indicators)

The NATWiP Framework template can be **downloaded here** as an Excel file; you can then apply it to our own nature-based solutions case study.

MAY YOU HAVE EVERY SUCCESS IN PURSUING NATURE-BASED SOLUTIONS THAT ARE SUSTAINABLE.

	Information Required	Specification	Examples
Settlement	Location	Continent Country City	
	Type		Urban, peri-urban, rural...
	Threats		Lack of legislation, absence from the state
	Opportunities		Labor participatory community
Problem and Scale	Challenge		Floods/ Drought/ Water suply/ Climates changes/ Society's involvement in problems/ Preserve spaces related to tje water cycle/ Awareness of the value of nature/ other
	Pressure	Local Scale Landscape Scale	Drug trafficking, real estate speculation, water pollution
	Actors Indentification		List of institutions in the area related to the target (local or regional government/ Covil society / Academia/ Industry / Other
Target	SDGs Association Other project in place		Goals number

APPENDIX 2

South African indicator spreadsheet

This is the completed NATWiP Framework for the two South African nature-based solutions. You can find an overview of: 1) the types of indicators that may be used for each of the three project phases (context, process and results); 2) the types of indicators used for all three dimensions of sustainability (economic, social, environmental); and 3) an illustration of how results may be captured through semi-structured surveys.

Please download the Excel file for the South African indicators **here.**

Key	
Perceptions	Different questions were directed to community members VS implementers
Empirical	Data taken from reports/literature
Questions/Comments	

South African case studies included in this spreadsheet

Genius, South Africa Dwars, South Africa

Sample Sizes

Genius of SPACE (community members: n=23; implementers: n=8)

Dwars River Rehabilitation (community members: n=20; implementers: n=3)

NATWiP is the acronym for a project titled "Nature-Based Solutions for Water Management in the Peri-Urban: Linking Ecological, Social and Economic Dimensions". This is a large transnational EU-Cooperation project funded under the Water Joint Programming Initiative (JPI) Call 2018.

The authors would like to thank the European Commission and the Swedish Research Council for Sustainable Development (FORMAS), Water Research Commission (WRC) in South Africa, Ministry of Economy, Industry and Competitiveness – through the State Research Agency (MINECO–AEI) in Spain & the Research Council of Norway (RCN) for funding in the frame of the collaborative international consortium NATWIP financed under the 2018 Joint Call of the WaterWorks2017 ERA-NET Cofund. This ERA-NET is an integral part of the activities developed by the Water JPI.

WEBSITE http://NATWiP.solutions

FOLLOW US facebook.com/nbsforwater