

Approaches to Monitoring and Evaluation Strategy Development

Dumitru, Adina; Garcia, Igone; Zorita, Saioa; Tomé-Lourido, Davidé; Cardinali, Marcel; Feliu, E.; Feroso, J.; Ferilli, G.; Guidolotti, G.; More Authors

DOI

[10.2777/244577](https://doi.org/10.2777/244577)

Publication date

2021

Document Version

Final published version

Published in

Evaluating the impact of nature-based solutions. A handbook for practitioners

Citation (APA)

Dumitru, A., Garcia, I., Zorita, S., Tomé-Lourido, D., Cardinali, M., Feliu, E., Feroso, J., Ferilli, G., Guidolotti, G., & More Authors (2021). Approaches to Monitoring and Evaluation Strategy Development. In D. Adina, & W. Laura (Eds.), *Evaluating the impact of nature-based solutions. A handbook for practitioners* (pp. 78-104). Publications Office of the European Union. <https://doi.org/10.2777/244577>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.



European
Commission

EVALUATING THE IMPACT OF NATURE-BASED SOLUTIONS

A Handbook for Practitioners

Independent
Expert
Report



Green space
management



Knowledge building
for sustainable urban
transformation



Place
regeneration



Health and
well-being



Participatory planning
and governance



Climate resilience



Biodiversity
enhancement



Water
management



New economic
opportunities and
green jobs



Natural and
climate hazards



Air quality



Social justice and
social cohesion

Research and
Innovation

Evaluating the Impact of Nature-based Solutions: A Handbook for Practitioners

European Commission
Directorate-General for Research and Innovation
Directorate C — Healthy Planet
Unit C3 — Climate and Planetary Boundaries

Contact Laura.PALOMO-RIOS@ec.europa.eu
Sofie.VANDEWOESTIJNE@ec.europa.eu
Email RTD-ENV-NATURE-BASED-SOLUTIONS@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu

European Commission
B-1049 Brussels

Manuscript completed in March 2021.
First edition.

This document has been prepared for the European Commission, however it reflects the views only of the authors, and the European Commission is not liable for any consequence stemming from the reuse of this publication.

More information on the European Union is available on the internet (<http://europa.eu>).

PDF	ISBN 978-92-76-22821-9	doi:10.2777/244577	KI-04-20-586-EN-N
-----	------------------------	--------------------	-------------------

Luxembourg: Publications Office of the European Union, 2021

© European Union, 2021



The reuse policy of European Commission documents is implemented based on Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under a Creative Commons Attribution 4.0 International (CC-BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated. For any use or reproduction of elements that are not owned by the European Union, permission may need to be sought directly from the respective rightholders.

Image credits:

cover: © MicroOne # 305386384, 2019. Source: stock.adobe.com

EUROPEAN COMMISSION

EVALUATING THE IMPACT OF
NATURE-BASED
SOLUTIONS

A Handbook for Practitioners

Adina Dumitru and Laura Wendling, Eds.

03

**What constitutes NBS monitoring?
How do I develop a robust NBS monitoring plan?
How can I execute monitoring and impact assessment activities?
What indicators of NBS impact can I use?
How do I select appropriate indicators of NBS impact?**

A step-by-step approach to developing robust monitoring and evaluation plans

NBS impact assessment best practices from EU H2020 projects

Why is it important to evaluate the impacts of NBS?

How can I ensure NBS work for Disaster Risk Reduction?

What kinds of NBS monitoring data can I gather, and how should I manage these data?

3 APPROACHES TO MONITORING AND EVALUATION STRATEGY DEVELOPMENT

Coordinating Lead authors

Dumitru, A., Garcia, I., Zorita, S., Tomé-Lourido, D.

Contributing authors

Cardinali, M., Feliu, E., Feroso, J., Ferilli, G., Guidolotti, G., Hölscher, K., Lodder, M., Reichborn-Kjennerud, K., Rinta-Hiiri, V., Maia, S.

Summary

What is this chapter of the Handbook about?

In this chapter, we outline a step-by-step approach to developing and implementing an impact assessment plan that covers all stages from planning and implementing to achieving policy impact. Understanding the specific steps to consider and follow when planning and implementing evaluation, will help practitioners make appropriate on-the-ground decisions that fit to their local context

We begin with introducing a structured reflection process that connects your strategic objectives, with NBS actions and expected outcomes, through the mapping of a theory of change, and the development of a logical chain of results that differentiates between process characteristics and outcomes (Section 3.1). We then delve into the steps involved in designing effective monitoring and evaluation plans (Section 3.2). Next we outline the key features and conditions



needed for a successful process of co-production of monitoring and evaluation plans, involving a diversity of stakeholders, from a quintuple helix perspective (Section 3.3). Finally, we present three innovative tools oriented to enhancing reflexivity in impact assessment and NBS design and implementation, more generally; to support the development of tailored monitoring and evaluation plans for local NBS; and to gather user data with the support of automatized procedures and technological devices (Section 3.4). The chapter concludes by stressing the role of robust monitoring and evaluation in evidence-based policy-making, the creation of a culture of continuous evaluation, and in stakeholder and citizen education (Section 3.5).

How do I use this chapter in my work with NBS?

You can use this chapter to develop your impact assessment strategy from the beginning of your NBS planning process. The chapter also outlines how monitoring and evaluation plans can feed into wider assessment, data collection, and reporting efforts, with a long-term view.

When should I use this knowledge in my work with NBS?

Monitoring and evaluation is sometimes considered too late in the process of NBS implementation that important opportunities are lost because of it. Therefore, we recommend that you use this chapter at the beginning of your planning process: it will enable you to have an overview of the steps you need to follow and thus save time and resources by initiating certain actions and collaborations early in the process. It might also be useful to review each step as you go through them, to ensure that you have considered all relevant aspects in each stage.

How does this chapter link with the other parts of the handbook?

After the in-depth description of principles that should be followed in developing robust impact assessment in chapter 2, this chapter describes the practical steps in detail, and outlines how impact assessment can be done through adopting a co-production approach. Specific indicators for each challenge category are then described in chapter 4. Considerations regarding data are discussed in chapter 5.

3.1 Introduction: developing robust impact assessment plans

Robust impact assessment is a key aspect of the urban and regional regeneration and resilience agenda in Europe. Nature-based solutions have emerged as a promising and potentially effective type of interventions for a variety of environmental, social and economic challenges. However, clear and sufficient

evidence on their different outcomes, the synergies and trade-offs between these, and the processes and pathways through which outcomes are achieved is still needed (Dumitru et al., 2020). Robust evaluation of nature-based solutions (NBS) in different cities and regions will contribute to an evidence base that can inform urban planning and interventions, investments and policy-making. In the medium and long term, it can contribute to the creation of a culture of impact assessment, as part of the design and implementation of nature-based and grey solutions.

As participants in the large-scale EC H2020 NBS projects described throughout this handbook, many cities and regions are defining local NBS monitoring and assessment plans and facing numerous challenges. Robust monitoring and evaluation plans provide important knowledge regarding the strengths and weaknesses of nature-based interventions, and the degree of achievement of the strategic objectives of the stakeholders involved. The effective development and implementation of these plans requires a thoughtful, step-by-step approach and active collaboration with local stakeholders. It is not a task that should be carried out in isolation, and this chapter seeks to offer orientation by describing in detail the step by step approach to monitoring and evaluation briefly outlined in Chapter 2, as well as outlining the key characteristics and stages involved in a co-production approach to impact assessment design and implementation.

Effective monitoring and evaluation plans have been identified as a key enabler for successful implementation of NBS (Ershad-Sarabi et al., 2019). In fact, when impact assessment plans follow, and are aligned with, local spatial development objectives, they support the transition to nature-based solutions design, by providing the evidence base for projects, plans and policies (Geneletti et al., 2016).

Collaborations between scientific experts, municipalities and other stakeholders are particularly helpful in the development and implementation of such robust impact assessment plans. Collaboration with local universities or urban professionals with scientific knowledge and experience is very valuable, as nature-based solutions have impacts across a wide range of contemporary challenges, thus requiring a wide range of scientific expertise (Raymond et al., 2017b). Successful co-creation experiences between researchers and policy officers in the design, implementation and maintenance of nature-based solutions leads to mutual learning and the establishment of relationships of trust (Frantzeskaki and Kabisch, 2016), facilitating long-term collaboration.

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

A robust monitoring and evaluation strategy requires careful planning from the beginning of the process of NBS design. By following a step-by-step approach, adequate resources can be assigned. To make sure evaluation is both robust and cost-effective. Teams in charge of developing and implementing a nature-based solution can work through a series of six sequential steps, already briefly summarized in Chapter 2. The process is not entirely linear, and feedback loops between some of the steps exist, as described below. A synthesis of these six steps and the relationships between them is presented in Figure 3.1, illustrating

how constructing a theory of change is an iterative process, and the feedback loop between steps 2 (outlining the sequence of results) and step 3 (specifying impact), which will feed into and help refine step 1 (the theory of change).

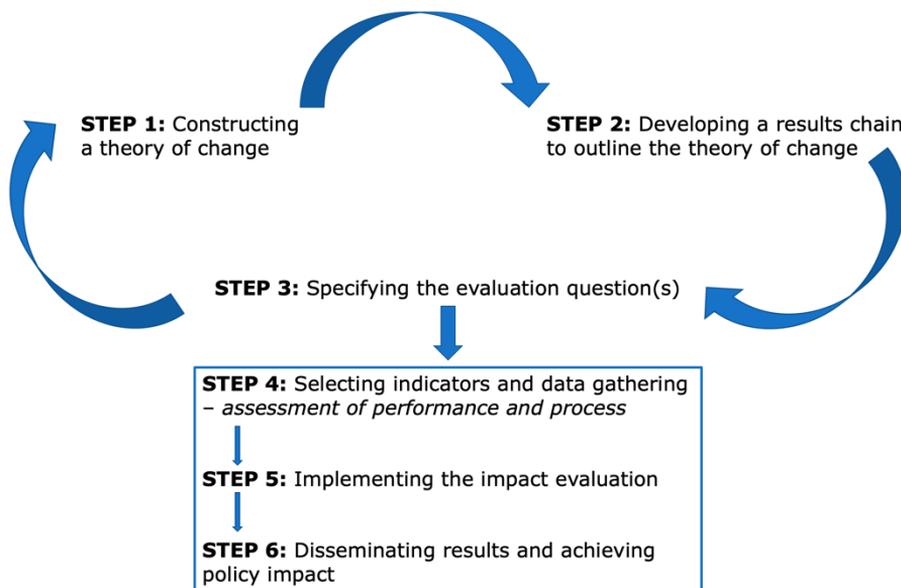


Figure 3-1. Summary of steps for developing impact monitoring and evaluation plans

STEP 1: Constructing a theory of change

The development of a theory of change enables planners and decision-makers to establish a clear relationship between key local context challenges, strategic objectives and the actions through which these will be reached, and fosters clear identification and reflection on the linkages, or pathways, between them. Developing a good theory of change takes time, but this effort will pay off in subsequent stages of monitoring and evaluation planning, by saving considerable time and money, through the anticipation and mitigation of errors. The following stages can be identified when developing a theory of change:

1.a) Engage in structured reflection on key local context challenges and NBS objectives

Structured reflection supports cities in establishing context-appropriate rationales for NBS implementation and establishing impact assessment objectives (Dumitru et al., 2021). Strategic objectives in a particular city or region are normally implemented by establishing more specific, local goals, and by identifying local challenges that call for specific policy interventions to achieve those goals. Developing a theory of change entails making these relations explicit with some degree of formalization, by providing answers to the following questions: which local goals are targeted; what city or regional strategic objectives they address; what nature-based solution/s and actions will address them; what, what specific

outcomes are expected at different stages of the change process and which specific outputs will be sought to achieve those outcomes.

Strategic goals are normally defined in strategic policy documents and defined in broad terms. Fitting or relating these to international targets such as the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda for Sustainable Development (2015) is helpful in adopting a bigger picture view of strategic objectives that will be addressed, among other, by NBS interventions and contributes to establishing connections between monitoring and evaluation efforts that are already taking place in the city or region. It also provides arguments to enhance collaborations between different stakeholders and acquire necessary funds for monitoring and evaluation.

A clear relationship should be established between specific NBS outcomes and the actions that need to be implemented at different stages, to produce those outcomes. Specific outputs should be listed for each of these actions and stakeholders should spend some time reflecting on potential interactions between outcomes that might lead to both positive synergies and unwanted trade-offs.

1.b) Involve the appropriate stakeholders and foster a sense of belonging to the process

Each stakeholder might have a different vision of the objectives to be set, the way to achieve them, or knowledge about the likelihood of different pathways connecting interventions to outcomes. Stakeholders also bring informed perspectives on local needs, as well as visions of the desired transformation and the role of NBS in achieving it. These points of view are not exclusive but complementary and will enrich the theory of change. An additional benefit of an approach that involves stakeholders from the beginning is that it fosters active engagement and a sense of belonging among stakeholders, as well as relationships of trust and cooperation (see Section 3.3 for additional detail).

Local teams responsible for monitoring and evaluation will benefit from holding regular meetings with stakeholders, in an iterative process. The vision of decision-makers will likely be enriched by other stakeholders' needs, desires, expertise and feedback on what may or may not work, and on the outputs and outcomes needed to achieve strategic goals and effectively address local challenges.

The presence of technical staff or a group of monitoring experts is important across the whole process of monitoring and evaluation, at varying intensities. Experts might be specialists in different categories of impacts or challenge areas, or in co-production activities, and they might also advise on the customization of the impact assessment plan to the capacities and resources of the city. Many times, local teams already have some technical expertise among their staff, which may be complemented with external resources, such as collaborations with scientists and universities. Experts' contribution will be essential in later stages of planning, when expertise on impact assessment methodologies and data collection is needed.

STEP 2: Developing a results chain to outline the theory of change

Following the clarification of local challenges, key local goals, and NBS actions to achieve them, stakeholders should explicitly identify assumptions regarding the mechanisms by which NBS actions will lead to expected impacts. Explicitly mapping the expected causal chain by which the implementation of the NBS will achieve strategic objectives, is useful in anticipating what may be missing in the design. Mapping causal pathways also allows for early detection of situations where NBS might not deliver all the envisioned outcomes, and beginning to ask the right questions about why that might be the case. Such a reflexive approach also fosters experimentation with tweaking design or with additional measures to improve NBS effectiveness over time.

When mapping causal pathways, the intermediary pathways through which an NBS, an NBS feature or an NBS action might lead to the expected outputs and outcomes should be clearly specified. Outcomes are the concrete results sought through the implementation of an NBS (e.g., reduce air temperature or increase mental health and wellbeing), while outputs are the visible part of NBS interventions necessary to fulfil the outcomes (e.g., create an urban green park; implement a participatory process of NBS design). The city has explicitly established its assumptions when it has achieved clarity, and can specify what actions will be carried out, what results are expected to be achieved through them, and what they think are the mechanisms that explain why an action is likely to lead to a particular outcome or result.

Imagine, for example, a neighbourhood who defines a series of strategic objectives of improving levels of physical activity in youth, and decides to create a neighbourhood park that would allow for people to be outdoors and exercise. In some cases, the assumption is that having the park in place would create recreational and exercise opportunities for youth, thus establishing a direct causal pathway between the existence of the park and physical activities. However, imagine now that the park is not accessible to a part of the neighbourhood because it does not have sufficient access points, or that particular socio-demographic groups such as cultural minorities or young women do not use the park as they do not feel safe in it. We start to see that we might need to consider additional pathways or conditions that lead to the expected outcome, such as accessibility of the park or perceived safety, and include them in the assessment.

Furthermore, two types of impacts can be distinguished. "Intended" impacts are the effects or changes that are not only desirable but are explicitly targeted through the NBS implementation. "Unintended" impacts are the (usually) negative, unforeseen results of NBS implementation. Also, each local team should establish its theory of change based on knowledge of the local context, since there are many factors that can influence the successful achievement of outputs and outcomes. Sometimes there are interrelationships of "positive effects", also called synergies (e.g., creating large tracts of urban green spaces favours biodiversity but also offers spaces for physical activity), while in other cases, there may be interrelationships of "negative effects" or trade-offs (e.g., creating parks that improve the perceived quality of urban environments, which in turn contributes to gentrification, and the exclusion of some groups).

Local teams should reflect upon and identify the possible intended and unintended impacts, as well as synergies and trade-offs that may occur across

the causal pathway. This will be of great importance in assigning causality, as described below.

STEP 3: Specifying the evaluation question(s)

The main reason for the development of robust NBS monitoring and evaluation plans is to establish the direct effect that these interventions have on addressing particular challenges and reaching certain objectives. As described in Chapter 2, impact evaluation is about answering causal questions: To what extent is this park contributing to reductions of obesity in a neighbourhood? To what extent is this urban garden contributing to reductions of depression rates in this neighbourhood, and through which mechanisms does it do so? Is it through increased physical activity, through simple exposure to nature, or through the fostering of increased contact and positive interactions between users? To what extent is this intervention more effective (if at all), than no intervention (where depression rates might improve anyway with the passing of time), or as compared to alternative, non-NBS interventions? Making these questions specific provides narrative context to the theory of change and orients the choice of appropriate indicators.

It is also useful to identify other factors that might influence the same outcomes in a given location and time period, as well as the relationship between NBS actions and outcomes. Some of these factors will be beyond decision-makers' control, but anticipating at least some of them will help with the correct attribution of causality, or, said differently, with knowing which are directly attributable to the NBS and which are not. Different options to correctly establish causal relations between NBS actions and outcomes have been outlined in Chapter 2.

STEP 4: Selecting indicators and data gathering methods - assessment of performance and process

Adequate indicators should allow for the assessment of *both performance and process*, and thus answer the following questions: does the NBS operate as designed and are outcomes consistent with the planned theory of change?

4.a) Select appropriate indicators

Throughout this handbook, indicators associated with 12 societal challenge areas (e.g., climate resilience, health and well-being, etc.) are presented. Each of these indicators has been developed using SMART (Specific, Measurable, Attributable, Realistic, and Time-bound) criteria, and each refers to the assessment of particular outcomes. Process indicators are also included, which refer to the characteristics of the NBS implementation process (e.g., number of stakeholders involved in the initial NBS design stage). When indicators are selected to assess one or several NBS projects, together they should form a coherent framework, considering the synergies and trade-offs mapped in the theory of change. In some cases, it is difficult to choose and measure all the desired outcomes and process features outlined in the previous steps, due to constraints in financial, human and

time resources. Therefore, in collaboration with the stakeholders, indicators will need to be ranked to establish priorities, to differentiate between those that are critical to the assessment of key NBS expected outcomes (recommended, or core, indicators) and those that might be desirable when additional resources and stakeholder collaborations are available and possible (additional indicators).

For each of the 12 challenge areas selected, Chapter 4 presents a set of recommended indicators, considered essential to mapping key outcomes of different types of nature-based solutions, and a set of additional indicators that might fit certain local contexts and types of nature-based solutions, but not others. Aware of the fact that resources are always limited to some extent, the list of core indicators has been kept to a minimum, while the list of additional indicators include a wide range of outcomes, and scientifically valid methods for their assessment. Local teams can start with the core indicators and progressively expand it over time, in line with policy priorities and resources.

Local teams can graphically illustrate which indicators are chosen for each of the important assumptions in their theory of change, through the use of causal maps, as illustrated by an example from the Connecting Nature project, presented in Figure 3-2.

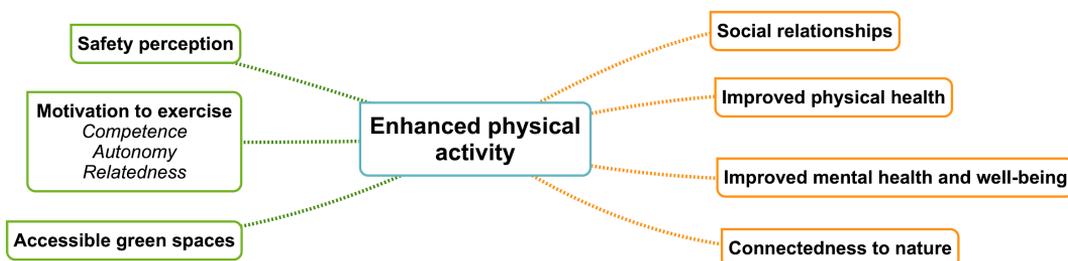


Figure 3-2. Indicator causal map
(adapted from Dumitru et al., 2021; approach used in the H2020 Connecting Nature project)

4.b) Choose an appropriate impact evaluation method

Once the indicators have been selected, within a coherent framework, the next phase will consist of identifying an appropriate method for each indicator. There may be more than one measurement method for each indicator (e.g., physical activity can be measured through a self-reported questionnaire, wearable devices or through heat maps). For each of the indicators presented in this Handbook, at least one measurement method is proposed. For those cases where end-users have to make decisions between several options, and choose a method adapted to their characteristics, the following three criteria outlined in Table 3-1 should be considered.

Table 3-1. Factors influencing selection of NBS impact evaluation measurement methods

Data quality	Involves the selection of standardized, scientifically-tested measurement instruments. High data quality is critical to enable drawing of valid conclusions, especially related to causality.
Temporal adequacy	Some NBS impacts will be registered shortly after NBS implementation, while others will take time. For example, reduction in the prevalence or incidence of different illnesses might need a long time span of 5-10 years to be registered. Frequency and temporal planning of measurements should take these aspects into account.
Cost-benefit ratio	Some methodologies provide highly detailed and accurate data but are very costly. When a particular impact is important for the city, or when over-time benefits are highly proportional to costs, these should be considered. High-quality, precise data pays off in the long term.

4.c) Identify and collect the data needed to assess selected indicators

After selecting appropriate indicators and methodologies, the next step is to identify available data and decide in which cases new data should be collected. In the previous chapter, the difference between baseline (prior to NBS implementation) and outcome data (data subsequent to NBS implementation) was explained (see also Figure 3.3). The absence of baseline data considerably limits the possibility of attributing impacts to the implementation of the NBS. Certain relationships may be observed, but it will be impossible to know for sure whether they are due to the NBS, or whether they might be due to other co-occurring phenomena.

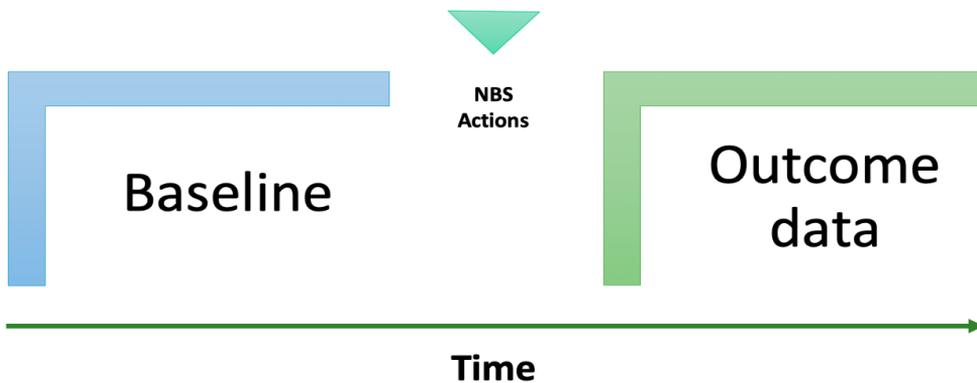


Figure 3-3. Baseline vs Outcome data (adapted from Dumitru et al., 2021)

It is strongly recommended to either detect data sources for the baseline and then collect outcome data, or, where data is not available, plan for baseline data collection before NBS design and implementation takes place. Moreover, given adequate resources, as well as the possibilities afforded by certain automatized

forms of data collection (such as wearable or remote sensors, smartphones, etc.) data might be also collected at several times before, during and after NBS implementation, thus allowing for higher precision and the detection of subtle variations as a result of NBS implementation.

In some cases, data is already available through public, private or third sector agencies at national or international levels. Thoroughly reviewing available data, as well as attempting to connect data collection with existing and regular survey, monitoring and reporting efforts at regional, national or international levels will mean that monitoring and evaluation of NBS can become a regular practice and be maintained and enriched over time.

4.d) Developing a local monitoring and data collection plan

The development of an effective local monitoring plan should consider a structured sequence of actions (CLES, 2010; Compass, 2010; United Nations, 2009), that together form a coherent data collection plan, with specific requirements regarding types of data, target populations and samples to be used, specific data analysis techniques and provisions for the protection and storage of data. Questions that the monitoring and data collection plan should answer are shown in Table 3-2. First, stakeholders should be assigned different roles in the monitoring and data collection process. These can be divided into four general categories: those in charge of making key strategic decisions; those in charge of particular research activities involved in monitoring; those carrying out the monitoring activities (the “fieldwork”), and those who provide general assistance or support across all stages. Secondly, tools for monitoring should be set in place, linked to the specific methods chosen for each indicator. These might include specific equipment, questionnaires, or enabling technologies. A monitoring schedule should be established, detailing when particular measurements will be taken. Finally, a clear data collection plan should be established, by providing answers to the following questions:

Table 3-2. Questions to answer through the local monitoring and data collection plan

<i>For the monitoring activities</i>	<i>For the data collection and storage plan</i>
What will be monitored? (includes expected outcomes and chosen indicators)	Which type of data will be collected and what is the target population or type of sample?
Where will monitoring take place? (location of monitoring tools and data collection)	Who will analyse the data? (which stakeholders or partners will perform the analyses)
Who will do the monitoring? (Stakeholders responsible for each type of data collection)	Who will store the data? (stakeholders responsible for the data platform and/or data base)
When will monitoring take place? (Schedule – times and frequency of data collection)	How will data be presented? (how the results of monitoring will be presented to inform policies, citizens and decision-making processes)

Throughout this process, risks may arise in data collection activities, such as delays in data collection, low response or unaffordable costs for municipalities. Establishing risk mitigation plans before the start of data collection will make it easier for local teams to avoid delays and inefficiencies.

STEP 5: Implementing the impact monitoring and evaluation plan

Implementing the impact evaluation, evaluating positive/negative features of NBS impacts related to the different challenges, analysing and interpreting the findings. Once data has been identified and collected, the next step is to analyse and interpret it, in order to assess NBS performance in achieving established objectives, and assess both positive and negative impacts, as well as synergies and trade-offs. This might entail looking at results of several impact evaluation rounds in combination as these may be relevant on the achievement of a particular objective. If several outcomes impacts (positive and/or negative) are considered in relation to an expected objective, the performance evaluation should consider trade-offs and possible differences in time scales over which indicators show that an objective has been achieved or not. Multi-criteria analysis may be used to consider the different views of stakeholders.

The results of the data analysis should be related to the initial objectives outlined in the theory of change. Local teams will thus be able to check whether NBS actions have had the expected impact, or, on the contrary, have had undesired effects. This is a good time to reflect on whether there are synergies between outcomes, or whether there are trade-offs. As Chapter 2 underlines, in case the results are not as expected, it is necessary to be careful when concluding that the NBS actions are not effective. Actions may have the expected effect, but over a longer time span.

Temporality is thus an element to consider in the global analysis of outcomes. Some impacts (e.g., promoting social cohesion in a neighbourhood) require a longer time to become apparent, while others can be verified almost immediately (e.g., reducing local temperature through green walls). It is strongly recommended to make evaluation an ongoing process, with different data collections over time, to better assess changes.

Furthermore, conclusions should not be drawn solely based on the change in an indicator before and after implementing the NBS, but to do a benchmarking process where scientific standards are taken into account that indicate which values are appropriate for an indicator (e.g., not only assess a decrease in pollution levels after implementing an NBS, but consider when the decrease is in line with scientific criteria). Figure 3-4 illustrates the monitoring strategy workflow used in the EU H2020 CLEVER Cities project, to illustrate the different stages involved in the implementation of a monitoring and data collection plan.

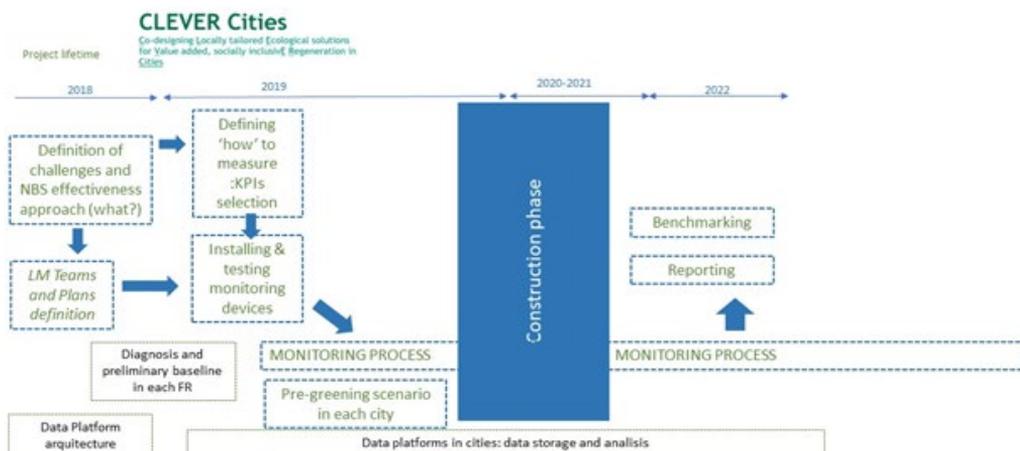


Figure 3-4. Impact Assessment process in the CLEVER cities project lifetime (Tecnalia, 2018)

STEP 6: Disseminating results and achieving policy impact

The last stage of the NBS impact assessment process involves the dissemination of results as well as making provisions to embed them into policy practice. The wider the dissemination, the more benefits it will have: citizens will be informed of the activities of their local government, companies will be made aware of business opportunities, and scientists will be able to continue advising on and researching the best methodologies for NBS impact assessment.

We stress the importance of not only registering and reporting positive results, tempting as that may be, but to do so for all the results obtained. Although it is often tempting to only consider and disseminate positive effects, knowing what has gone wrong or which parts of the implementation are susceptible to improvement in the future are of utmost importance in order to not repeat mistakes or waste resources by implementing the same ineffective strategies and solutions elsewhere. It is also very important to disseminate both outcome and process results. Reporting all results will mean that knowledge and evidence will accumulate, benefitting everyone working with NBS.

Disseminating the knowledge generated by the local team to others not only helps in the replicability of NBS, but also positions city councils as role model. Different collaborative actions can be carried out to help disseminate the data, such as scientific articles, official reports, conference presentations, talks and webinars, or social- and mass-media interviews. It is also very helpful to create integrated and highly visual representations of impacts, and where possible include a spatial or GIS component to the visualization of the data, to support decision-making. The more attractive and easier to navigate these data dissemination platforms are, the more they will enable stakeholder collaboration and evidence-based decision-making in the future.

The creation of NBS impact dashboards by cities or regions, which integrate GIS technology, and allow interaction with different types of data, are gaining

prominence. The following image is an example of the impact dashboard created in the city of Glasgow as part of the Connecting Nature project, as a way to map and represent outcomes of the City's Open Space Strategy and the impacts of NBS implementation in different areas. The dashboard allows viewers to visualize the interplay of different indicators (e.g. health status, social deprivation, green space distribution) in a particular city location, and provides a flexible structure that will be further developed as additional NBS are implemented and additional data becomes available. It is also a useful instrument to identify types of indicators and data that might be missing, thus orienting future impact assessment decisions.

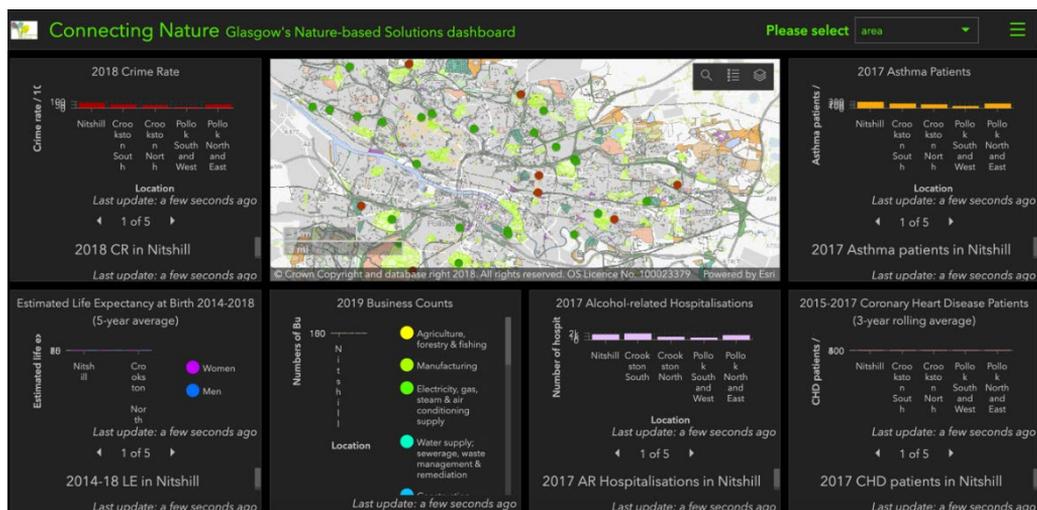


Figure 3-5. Glasgow City Council Dashboard (© Glasgow City Council), the Connecting Nature Project

3.3 Robust impact assessment and co-production: a necessary relationship

The design, implementation and evaluation of nature-based solutions require the collaboration of different stakeholders. Although the design and implementation of monitoring and evaluation plans is often considered the part of the process where most technical and scientific expertise is required, we argue that monitoring and evaluation can also benefit from collaborative, co-productive approaches. The knowledge, expertise and lived experience of many stakeholders is relevant when deciding what outcomes to evaluate, when identifying existing local needs, as well as when implementing monitoring strategies and gathering relevant data. Using well-designed collaborative approaches can also reduce costs and enhance NBS ownership, as, for example, when using citizen science approaches to monitor biodiversity. Even for the most technical parts of monitoring and evaluation, such as deciding on where and when to use certain equipment for data collection, using a collaborative approach can ensure that residents are knowledgeable of the reasons for it, and they can contribute to equipment maintenance and/or safety. Citizen participation in monitoring and

evaluation efforts can enhance socially innovative solutions and accelerate the transition to sustainability (Faivre et al., 2017).

Moreover, the multifunctional nature of nature-based solutions will mean that different administrative departments and agencies will need to be involved in monitoring and evaluation (Calliari et al., 2019). Monitoring NBS impacts in different urban, rural or coastal conditions advances the knowledge acquired by local authorities (Frantzeskaki et al., 2019). Co-production will provide opportunities to change traditional ways of thinking and planning (Bush and Doyon, 2019). Impact assessment might require the use of data collected and kept in the custody of different departments, thus overcoming data and monitoring silos. Changing traditional silo-type modes of operation, where ecological, social and economic objectives are considered separately, the focus needs to shift to a broader conceptualization of urban resilience and regeneration (Dumitru et al., 2020), and to an institutional culture of cooperation (Frantzeskaki et al., 2019). Finally, business sector stakeholders can provide valuable information related to the economic and environmental dimensions of the NBS. Different stakeholders help to highlight weaknesses, to prioritize interventions and to identify the adequacy of assessment tools for diverse locations (Beceiro et al., 2020).

The degree of stakeholder participation will depend on whether their points of view are taken into consideration by local governments and on their proximity to the decision-making process of interventions (Wamsler, 2017). Planners can think of this in terms of a continuum, ranging from centralized, hierarchical decision-making to decentralized, participatory monitoring and evaluation where stakeholders take joint ownership of the process and are actively engaged at each stage. Different models, or positions on this continuum, have their pros and cons. Centralized or hierarchical decision-making models ensure a fast and potentially less expensive process, but can be seen as poor processes by the citizens and generate reactivity, thus undermining acceptability of different NBS strategies and projects. On the other side of the continuum, participatory models require a greater investment of resources (time and budget), but contribute to citizen ownership of the solution, the creation of a culture of collaboration and engagement, as well as a sense of community and belonging, and in the long term might lower costs through good maintenance of the solution by the community. Co-production approaches will also foster greater NBS-related business opportunities through engagement with the business sector, as well as increased network creation and trust-building.

Co-production is different from consultation or information provision, and the key differentiating feature is that stakeholders are involved from the very beginning in the development of monitoring and evaluation plans, in each of the steps described in section 3.2.

We highlight five stages that are important for the co-production of impact assessment plans. Importantly, outlining a co-production strategy and creating specific co-production plans should happen at the very beginning of the process of NBS design and implementation. Co-production stages are also iterative. It is important to continuously reflect, redefine and adapt the process of monitoring and evaluation co-production if and when needed.

It is also important to keep in mind that co-production is not a panacea. Ensuring good quality co-production requires the development and strengthening of new types of skills, resources and relationships to foster exchange and collaboration between stakeholders. It is thus of paramount importance to take time at the outset of the process to establish good relationships with stakeholders from the outset, for which good communication skills and openness to multiple perspectives is helpful. We highlight here the key stages in the planning and implementation of an effective co-production process.

Stage1: Define the goals of, and create space for, the co-production process

The goal of co-production of monitoring and evaluation of nature-based solutions should be clarified from the start, by addressing questions such as: To what ends do stakeholders need to be involved? Which amount of time needs to be allocated to the co-production process? The goals need to be clearly communicated to potential funders as well as participants. People are more likely to become actively engaged when outcomes are clearly visible, and their opinions are authentically considered and appreciated.

Answers to these questions will determine the goals that influence which actors should be involved and in which steps of the process. Depending on the objectives and time availability, the goals of co-production can pertain to each of the steps outlined above, or a choice can be made to involve (different types of) stakeholders in specific steps. For example, in the development of a theory of change (Step 1), cities can benefit from the knowledge of the various stakeholders to understand local needs, desires for change and how the NBS can address them. Shared aspirations for outcomes can be formulated collaboratively from the beginning. Other stakeholders can be involved later on in the collection and interpretation of data (Step 5), as well as in debates and decisions on how to adapt the NBS to improve outcomes.

Co-production requires a high amount of time and resources, openness and trust, as well as (political) support and motivated participants. This needs to be considered in the initial goal setting and time planning to allow and plan for sufficient availability of time for things like initial preparation of the co-production process, mobilisation of stakeholders or processing information for each subsequent monitoring and evaluation step.

Stage 2: Identify and reach out to the actors that will be involved

Secondly, the actors that are sought to be involved need to be identified and contacted. Who should be involved depends on the nature-based solution itself, including where it is located and who is affected. It is important to explicitly go beyond the usual suspects to guarantee greater inclusion and participation of the weakest and give voice to critical perspectives.

Actor mapping tools facilitate the identification of suitable participants. The Quintuple Helix approach helps identify key stakeholders across different audiences to be targeted as part of the co-production process: 1) Academic; 2) Industry, firms, economic system; 3) State, government, local political system;

4) Media-based and culture-based public – local communities, community groups, NGO’s – mainstream and local media, environmental media; 5) Natural environments of society – NGO’s, policy makers, political bodies, experts and opinion leaders on NBS.

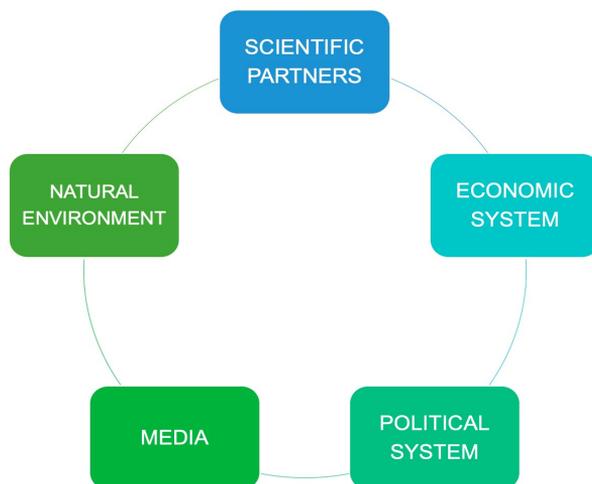


Figure 3-6. Quintuple Helix Stakeholders (adapted from Carayannis, Barth, and Campbell, 2012; Dumitru et al., 2020)

It is important that stakeholders in each of these categories are identified early on, and decisions are made about how they might be engaged, depending on the objectives identified. We should not only consider the type of knowledge these stakeholders can provide at different monitoring and evaluation stages, but also what type of knowledge and expertise might they also acquire through this process, how the process can contribute to building confidence among some of the more vulnerable stakeholders, and empower them for further meaningful participation in the implementation of the NBS.

Mobilising diverse actors requires boosting and tapping into motivation for participation. While people might be intrinsically motivated, co-production requires time, effort and money, and (shared) benefits might only be felt in the long-term. Levers for motivation can include money-related complements (e.g., financial support, training), but also social, cultural and psychological factors including social rewards, feeling part of a group and socialisation of the behaviour of participation and collaboration.

Actively going out to communities and holding regular meetings that are open to all are important conditions for enabling co-production. In addition, adequate follow-up is essential: when participants feel that they have wasted their time, they might become frustrated and disempowered to take up initiative in the next stages. Each meeting and discussion stage should be followed by feedback and the integration of issues raised into the subsequent discussions in a meaningful way (or at least providing reasons for why particular ideas might not be possible, or were not integrated). It is also important to monitor who does (and does not!) benefit from the results.

Additionally, the different roles and responsibilities for organising the co-production process need to be defined. Think of roles and responsibilities in terms of process design, facilitation, aggregating the generated knowledge, communicating results etc. The co-definition of roles and responsibilities in the process gives clarity about what is expected from actors and helps them feel comfortable in and adopting their (new) roles and functions.

One of the challenges of co-production is balancing all the interests and needs. For example, each stakeholder might have a different vision about the objectives to be set in the city's theory of change. Inclusive co-production means that the process format is based on mutuality, reciprocity and equality between different groups (e.g., experts, citizens), for example in terms of considering capabilities and time restrictions of different groups and giving equal voice to everyone. Communication and engagement need to consider the different capabilities, values, languages and resources of participants, as well as potential pre-existing cooperation or contestation between actors and institutional power structures. Ideally, this allows for open discussion and sharing of opinions in a joint learning setting, which builds on the recognition that different views are not exclusive but complementary.

Stage 3: Plan the co-production activities and tools

Thirdly, the co-production activities have to be planned with a timeline of when these are going to happen. The main question to be addressed here is 'how', relating to the right type of formats and tools to engage with the stakeholders. For example: How should different actors be involved in the construction of a theory of change? How will they be involved in the selection of indicators and data collection?

Specific co-production tools facilitate each step of the process towards desired goals. Tools are highly diverse. The choice of tools depends on the goals of the co-production process, on the specific impact monitoring and evaluation step, and on the type of actors involved. For example, visioning exercises serve to generate inspiring future images and ideas; they are particularly useful at the beginning to support the development of a theory of change, as well as to align diverse actors and to create long-term, systemic and normative aspirations. Citizen science approaches can support wide data generation, but need to be complemented with workshops for joint reflection upon the data.

Citizen science refers to public participation in scientific research and projects, not only to collaborate with scientists collecting data but also has the potential to engage the public in research by modifying the knowledge, attitudes and behaviour of citizens (Peter et al., 2019). This participatory research can promote the efficiency and effectiveness of research processes, as well as foster social inclusion, empowerment and sustainability (van de Gevel et al., 2020). Citizen participation through citizen science can provide a wealth of data to create evidence that can address real-world problems, which would otherwise be insurmountable for small teams of professionals (Gildefer et al., 2019)

Performing a classification of citizen science projects, linked to voluntary forms of participation, Follet and Strezov (2015), grouped these projects into: a) contributory projects: citizens participate in data collection and analysis, as well

as in the dissemination of results; b) collaborative projects: in addition to the previous functions, the participants would help in the design of the study and interpretation of the data and conclusions; c) co-created projects: collaboration would be carried out at all stages of the project, from the development of hypotheses to the discussion of results, and the answer to new research questions. Therefore, in the monitoring of the NBS, citizens can be involved from the co-design of the strategic objectives of the local authorities, until the last phases of data collection and transfer of results.

Although citizen science approaches have a lot of potential, they are not appropriate for all types of outcomes assessed, especially those for which specific expertise is required (Wamsler et al., 2020). Although the data collected by citizens may sometimes have levels of accuracy similar to the data collected by experts, participants need to be engaged for long time periods in larger groups and with specific training (Aceves-Bueno et al., 2017).

The co-production activities and tools need to be planned from the outset, following along the steps for impact assessment and monitoring, but also considering that the process will likely need to change and adapt.

After selecting the co-production tools, it is important to identify the materials, skills and other requirements needed to implement the tool. Think for example of the space/room, atmosphere and time needed.

Stage 4: Reflect on the co-production process and results

Co-production processes are never set in stone. They are open processes and evolve over time as learning progresses. They 'go with the flow' of the participants' ideas and needs. This requires continuous reflexivity. Reflexivity helps to identify lessons learned and to adapt the process in light of (changing) objectives. Which goals does the process aim to achieve? Is the process on the way to achieve these, or do we need adaptations? Reflexive monitoring can help to achieve reflexivity (see section 3.4.1).

Stage 5: Communicate about the co-production process

The co-production process and results need to be politically and societally known and accepted. This closely links to Step 6 (dissemination of results and achieving policy impact) of the impact monitoring and evaluation plans. This can be achieved through outreach and awareness raising activities such as campaigns and public events. Communication formats should be accessible, tailored to and inclusive of different target audiences, use innovative techniques (e.g., storytelling, puppet play, etc.), tell an inspiring story and clearly articulate the results. The participants of the process can be actively engaged in such activities.

If the evaluation and monitoring process is broadly known, greater collaboration can be achieved and thus obtain data from more sources, therefore, co-operation with the media can help disseminate the importance of evaluation. Finally, science-practices partners (i.e., universities, research institutes, etc.) serve as guides in cities to carry out each of the steps of the process. Academic entities can establish synergistic collaborations with cities, being able to use the evaluation results to disseminate them internationally, and to accumulate more

evidence on the NBS. Successful approaches can then be transferred between case studies, communities and countries (Raymond et al., 2017a), with the support of the established networks.

3.4 Innovative tools for monitoring and evaluation of nature-based solutions

Monitoring and evaluation of nature-based solutions can benefit significantly from technology-supported innovations. Collaborative technological approaches have been encouraged (Ershad-Sarabi et al., 2019), and the existence of new platforms that facilitate co-production and interaction between citizens and governments, especially in the context of urban development, has been highlighted (Falco and Kleinhans, 2018). We provide a few examples of innovative methodologies for monitoring and evaluation: a collaborative approach to enhance structured reflection and reflexivity regarding monitoring and evaluation; an online tool to create robust monitoring and evaluation plans; and a smartphone-supported, automatized data collection and citizen engagement tool.

3.4.1 Reflexive monitoring - Connecting Nature project

Reflexive monitoring is a participatory and dynamic monitoring and learning process that enables practitioners to gain insight into the progress and direction of their nature-based solution project in real time, and not only retrospectively. Reflexive monitoring stimulates learning, supports the identification of barriers and opportunities and enables flexible responses to changing circumstances and objectives. It is about adopting a reflexive mind set: reflexivity is the ability to interact with and alter the environment within which one operates. This allows practitioners to take actions that influence the context in which they work for the implementation of their nature-based solution. It is a particularly useful process for the nature-based solution core project team, although it can be adapted to involve and stimulate reflexivity among a wider range of stakeholders.

Reflexive monitoring can help for example with continuous reflection about whether indicators fit the outcomes and goals of the project or whether they need adaptation, or the appropriateness of data and data collection. It can also support reflection about the process itself, including whether there needs to be more time for co-production, or whether the right stakeholders are involved.

Within the H2020 Connecting Nature project, the innovative reflexive monitoring tool has supported cities in reflecting on their progress in the planning, delivery, evaluation, and stewardship of NBS, being able to record what actions allowed them to overcome the difficulties encountered. The following section is based on the Reflexive Monitoring Guidebook by Lodder et al (2020). The Connecting Nature cities of Genk (Belgium), Glasgow (Scotland) and Poznan (Poland) have found it is wise to reserve space and time to become familiar with the steps and the tools before proceeding with them. Once the reflexive monitoring process is aligned with your daily activities, you will be able to identify the benefits and act on what you learn.

For the Connecting Nature cities, a six-step procedure (see Figure 3.7) has been developed to implement the reflexive monitoring process. These steps can be applied in parallel to the steps for developing impact monitoring and evaluation plans. Reflexive monitoring should accompany all the steps outlined for robust impact assessment.

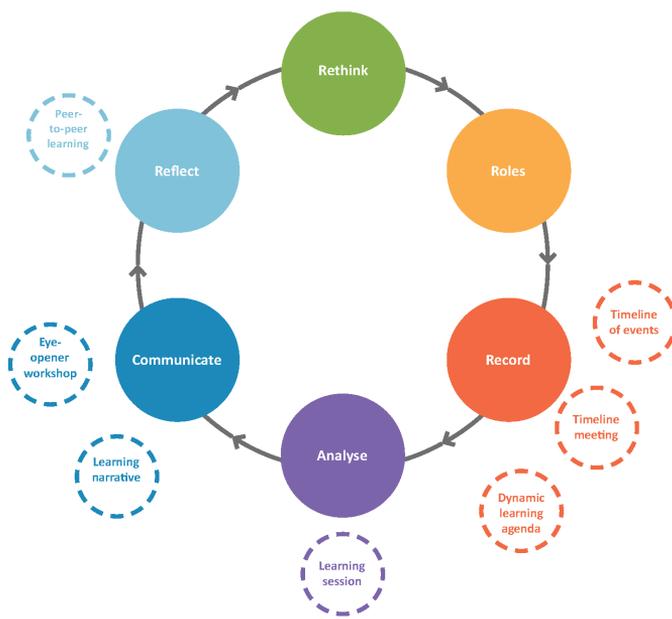


Figure 3-7. Steps in the reflexive monitoring process with accompanying tools (source: Lodder et al., 2020)

The reflexive monitoring process outlined below is supported by seven reflexive monitoring tools which may be applied by NBS practitioners. The tools are based on a selection of the tools presented in the Reflexive Monitoring in Action guidebook by Van Mierlo et al (2010).

RM step 1: Rethink what learning process you need to achieve the goals of the Nature-based Solution

When describing the process of co-production, we stressed the importance of clearly defined co-production goals. Beyond the goals of the nature-based solution, and the process of co-production, we also recommend identifying clear learning goals for the different actors involved. It includes how the process of NBS design and implementation is different from other planning processes, and the different departments that need to be involved. Next, it is important to acknowledge that reflexive monitoring is a novel process for all actors involved. For it to be successful you need to plan for space and time to get acquainted with the tools and to include them into your daily activities.

RM step 2: Define the roles within the project team

From the very outset of the reflexive monitoring process, it should be made clear that each actor has a role in the process and that exercising this role will involve collaborating closely and meeting regularly. The level of involvement of each one depends on the steps in the process.

RM step 3: Start with recording important events and translate them into your dynamic learning agenda

Start with recording a timeline of events during one or two months. This is to trace important moments, insights, events, that influence the development of the impact monitoring and evaluation plan. Discuss the timeline of events with your project team and distil important moments in time where something changed that helped or hindered to process. Include the critical turning points to your dynamic learning agenda and add learning questions and follow-up questions for each turning point. This allows for collective reflection on the essence and difficulty of the challenges that are dynamic and change over time. The objective of the dynamic learning agenda is to link long-term aims and learning objectives to concrete actions in the short term. By formulating, recording and tracking challenges in time the learning journey itself can be evaluated as a dynamic process.

RM step 4: Use learning sessions to identify learning outcomes

This step is about supporting the team to improve the learning process and analyse the outcomes. To facilitate this, we recommend the organising of learning sessions with the reflexive monitoring team. During the learning sessions each newly added item on the dynamic learning agenda is discussed. The critical turning points in the development of the project and learning questions are discussed and if needed reformulated to increase their reflexivity. After all items on the dynamic learning agenda are discussed, the expert and team identify learning outcomes. Learning outcomes are innovative ways the team handles the barriers or opportunities captured in the dynamic learning agenda.

We operationalized a framework for reflexive learning outcomes based on Beers and Van Mierlo (2017) that distinguish between the following categories: (1) Rules guiding actors' practices, for example tendering procedures or the way a city department is organised; (2) Relations between actors and between the nature-based solution and its context, for example who is involved in the planning process; (3) Practices concerning common ways of working, for example how the team collaborates internally; and (4) Discourse related to the future of the nature-based solutions, for example the way a mayor talks about the benefits of nature-based solutions for the city. Analysing learning outcomes in detail helps the team to better understand and explain to others what they learnt, identify remaining gaps in knowledge that can be covered through additional stakeholder collaboration or training and capacity building exercises, and highlight innovations in urban planning, including the monitoring and evaluation dimension of NBS.

RM step 5: Communicate about the reflexive monitoring process to peers and project outsiders

Reflexive monitoring is a novel governance process that allows many lessons to be learned. It is valuable to share these lessons, along with tips and tricks, with other actors who might benefit from the method. The following two tools are selected to support this exchange: the eye-opener workshop and the personal learning narrative. The purpose of eye-opener workshops is to share what is learned from co-producing nature-based solutions with people who are not yet involved in your project. For example, colleagues from other departments, the mayor's office or professionals working with co-production or involved in nature-based solutions projects. Personal learning narratives are stories that describe the learning journey of yourself or your team members throughout the co-production process. These may take the form of an experience, a hindering factor, a struggle or a challenge. These personal stories can be shared in different ways to supplement regular reports. For example, a participant records a video about his or her own learning journey and it is shared through social media or played at an eye-opener workshop.

RM step 6: Reflect upon reflexive monitoring as a method for knowledge generation regarding how to educate about the multiple benefits of nature-based solutions and how to adapt the planning process in real-time

In step six, sessions can be organised to reflect upon the effectiveness of the reflexive monitoring method itself and compare and share the learning outcomes. These sessions give practitioners the chance to share their experience of working through the various steps and using the tools of the method, which may in turn be adapted based on the feedback received or changing needs. Peer-to-peer learning events can be used for the sharing and comparing of the learning outcomes of different teams. Think of organising sessions to learn how others dealt with similar challenges and barriers, sharing personal learning narratives and celebrating innovations to inspire each other.

3.4.2 iAPT (Impact Assessment Planning Tool) - Connecting Nature project

Developed within the Connecting Nature Project, iAPT is intended to be a decision-support tool for cities to create their NBS evaluation and monitoring plans. The main objective is that users, mostly urban planners, can obtain their individualized monitoring and evaluation plan adapted to the characteristics of their location, online, easily and intuitively.

The tool supports planners and project teams to go through an abbreviated version of the step by step process described at the beginning of this chapter. After users indicate some characteristics of the location, placing it on an interactive map, they outline their theory of change, by reflecting on the characteristics of their NBS and explicitly relating them to certain outcomes, by choose from a list of possible impacts grouped into different impact categories (e.g., health and wellbeing, social cohesion, greenspace management, etc.).

Once users have made their initial selection of benefits, iAPT provides suggestions regarding relevant indicators to assess identified expected outcomes. Users will be able to consult a series of factsheets regarding methodologies for particular indicators to get a better idea of what they represent and what methods and measurements can be used for them. While users will select which indicators to measure, iAPT will suggest other indicators that are equally important and might not have been considered by the project team, to create a coherent impact assessment framework that reflects the multifunctional character of nature-based solutions.

Subsequently, iAPT will offer various methodological options for each of the indicators. As explained in this chapter, users must make the choice considering three criteria: data quality, temporal adequacy, and the cost-benefit ratio. The tool will be connected to the recently launched Connecting Nature-Based Enterprise platform, to suggest nature-based enterprises or experts that provide support or services for a given monitoring and evaluation step or component.

Finally, users will be able to obtain and download a specific assessment plan for their NBS, adapted to their location. This plan will contain the selected indicators, how to measure them, as well as supplementary material and methodological recommendations. Users can carry out the customization process as many times as they deem convenient. Future developments of this tool could link the evaluation plans with real data of the indicators, to complete the whole process of data analysis and help in the dissemination of results.

3.4.3 Urban GreenUP Tool - Urban GreenUP project

As part of the monitoring strategy of the city of Valladolid, a smartphone application has been developed by GMV, within the Urban GreenUP Project. This is an example of an innovative technology-supported data collection platform, conceived to act as another sensor for the monitoring program of the city, and track both the interest generated by the NBS in citizens, as well as to assess the use of the Green Corridor. The application will allow the collection of various interrelated data relating to a specific user (with an identified profile). Some of these data are collected automatically, by leveraging Smartphone sensor (positioning by GPS/BT; position and time spent in an NBS), and others will be actively filled in by the user (surveys, ratings). All the information provided by the users is treated anonymously.

The smartphone application is also designed to raise awareness and increase nature-based solutions engagement, showing a notification if it detects that the user is near a relevant location, and providing information regarding the purpose of the deployed or planned NBS. It can contribute to data collection for the following challenges: Green space management (Sustainability of green areas; Quality of life for elderly people; Perceptions of connectivity and mobility; Recreational cultural value); Participatory planning and governance (Perceptions of citizens on urban nature); Social justice and social cohesion (Green intelligence awareness); Public health and well-being (Increase in walking and cycling in and around areas of interventions).



Figure 3-8. URBAN GreenUP tool (Source: GMV-S).

Acknowledgements: Fátima López Mateos, Jesús Ortuño Castillo [GMV, URBAN GreenUP partners], Alicia Villazán Cabrero [Valladolid City Council, URBAN GreenUP partners and front-runner city]

Moreover, the smartphone application promotes the use of the green corridor throughout scoreboards and gamification. A scoreboard can serve to motivate the users through the use of rankings, or by providing information on usage scores in general. It also serves as a vehicle for promotions and discounts related to the NBS. The information will be sent to a server platform that will store the actions and information provided by the users (location and information). Data collected will be used to calculate some of the indicators for the Valladolid monitoring program. Currently, the use of the App and data beyond the European project is not foreseen, but could be an option to consider in the future. For the municipality, this data collection is important not only in terms of assessing the impact of the URBAN GreenUP project as a whole but also as an indicator of the degree of citizen acceptance of the re-naturalization actions implemented by the City Council.

The application will allow the collection of various interrelated data relating to a specific user (with an identified profile). Some of these data are collected automatically (position and time spent in an NBS), and others will be actively filled in by the user (surveys, ratings). The information provided by citizens when completing their profile is used to segment the results providing data for monitoring and evaluation by social groups. This segmented analysis of how each social profile uses and perceives NBS can be applied in the design of future urban re-naturalization plans

This monitoring system is a considerable improvement over more traditional monitoring methods. As a main advantage, the use of these technologies encourages the interaction of citizens and their participation in the design of their own town. As a drawback, it should be noted that the population sample studied is only that which handles these technologies and maybe a non-representative population sample.

Although the app is not open source and has been specifically designed for Valladolid city and their specific NBS actions, functionalities can be adapted to other cities.

3.5 Conclusions

Throughout this chapter, the importance of developing robust evaluation and monitoring plans has been emphasized, to assess the processes, outputs and outcomes involved in NBS design and implementation. Also highlighted in this chapter is the idea that NBS impact assessment should not be conducted in isolation by local authorities, but must have the support and active collaboration of multiple stakeholders such as scientists, companies, media, citizens and policy makers. The closer local teams are to the co-production end of the continuum, the richer, more effective and less costly impact assessment will be, while acceptability, empowerment of vulnerable groups and the creation of a culture of NBS evaluation will also be fostered.

Monitoring and evaluation in cities and regions can also have a clear educational role, since it is possible to learn from mistakes and disseminate successes (Pappalardo and La Rosa, 2020). Evaluation contributes to the development of long-term plans and goals for NBS (Kabisch et al., 2016), and leads to new insights and active learning, including failures, to improve future implementations (Connop et al., 2016). Impact assessment should be carried out across multiple categories of impacts, and synergies between outcomes should be considered, as well as NBS evolution over time (Calliari et al., 2019).

Throughout this handbook, you will find descriptions of many different European NBS projects and their monitoring and evaluation frameworks and strategies. They illustrate the step-by-step approach outlined at the beginning of this chapter, and are examples of different co-production strategies for monitoring and evaluation. Many of the difficulties encountered revolved around the lack of an evaluation culture on at local levels, which resulted in monitoring and evaluation not being planned from the beginning, as well as to many misconceptions about indicators, methodologies, costs and efforts. Collaboration between scientists, technical experts, municipalities and other stakeholders contributed to overcoming these barriers and advancing knowledge on conditions for successful and robust impact evaluation for nature-based solutions. Lessons from all these projects have been captured in the principles and approaches described here.

The ultimate goal of the process of creating robust impact assessment plans on a local level is to gather long-term robust evidence regarding NBS performance in particular spatial contexts and for different social groups, and to embed this evidence to support smart policy decisions to foster sustainability, wellbeing, and resilience (Dumitru et al., 2021). By establishing a culture of periodic evaluation, local authorities will be able to learn with each intervention and get as close as possible to achieving their strategic goals and building sustainable and socially just environments.

3.5 References

- Aceves-Bueno, E., Adeleye, A.S., Feraud, M., Huang, Y., Tao, M., Yang, Y., and Anderson, S. E., 'The accuracy of citizen science data: a quantitative review', *Bulletin of the Ecological Society of America*, Vol. 98, No 4, 2017, pp. 278-290.
- Beceiro, P., Brito, R.S., and Galvão, A., 'The Contribution of NBS to Urban Resilience in Stormwater Management and Control: A Framework with Stakeholder Validation', *Sustainability*, Vol. 12, No 6, 2020, Art. no 2537.
- Beers, P.J. and van Mierlo, B., 'Reflexivity and learning in system innovation processes', *Sociologia Ruralis*, Vol.57, No 3, 2017, pp. 415-436.
- Brandsen, T. and Honingh, M., 'Distinguishing different types of coproduction: A conceptual analysis based on the classical definitions', *Public Administration Review*, Vol. 76, No 3, 2016, pp. 427-435.
- Bush, J. and Doyon, A., 'Building urban resilience with nature-based solutions: How can urban planning contribute?', *Cities*, Vol. 95, 2019, Art. no 102483.
- Calliari, E., Staccione, A., and Mysiak, J., 'An assessment framework for climate-proof nature-based solutions', *Science of the Total Environment*, Vol. 656, 2019, pp. 691-700.
- Carayannis, E.G., Barth, T.D., and Campbell, D.F., 'The Quintuple Helix innovation model: global warming as a challenge and driver for innovation', *Journal of Innovation and Entrepreneurship*, Vol. 1, No 1, 2012, pp. 1-12.
- Cardno, *Toolkit for Monitoring and Evaluation Data Collection, Pacific Women Shaping Pacific Development*, Cardno Emerging Markets, Brisbane, 2017.
- CARE Emergency Group, *Monitoring and Evaluation Toolkit*, CARE Emergency Group, 2017. Retrieved from <https://www.careemergencytoolkit.org/management/9-monitoring-and-evaluation/>
- CLES, *Evaluating regeneration projects and programmes*, Centre for Local Economic Strategies, Manchester, 2010.
- Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C.R., Renauld, F.G., Welling, R., and Walters, G., 'Core principles for successfully implementing and upscaling Nature-based Solutions', *Environmental Science and Policy*, Vol. 98, 2019, pp. 20-29.
- Compass, *How to Develop a Monitoring and Evaluation Plan*, Springboard Compass, 2010. Retrieved from: <https://www.thecompassforsbc.org/how-to-guides/how-develop-monitoring-and-evaluation-plan>
- Connop, S., Vandergert, P., Eisenberg, B., Collier, M.J., Nash, C., Clough, J., and Newport, D., 'Renaturing cities using a regionally-focused biodiversity-led multifunctional benefits approach to urban green infrastructure', *Environmental Science and Policy*, Vol. 62, 2016, pp. 99-111.
- Creswell, J.W. and Creswell, J.D., *Research design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications, Thousand Oaks, 2018.
- Djenontin, I.N.S. and Meadow, A.M., 'The art of co-production of knowledge in environmental sciences and management: lessons from international practice', *Environmental Management*, Vol. 61, No 6, 2018, pp. 885-903.
- Dumitru, A., Frantzeskaki, N., and Collier, M., 'Identifying principles for the design of robust impact evaluation frameworks for nature-based solutions in cities', *Environmental Science and Policy*, Vol. 112, 2020, pp. 107-116.
- Dumitru, A., Tomé-Lourido, D., Young, C., Connop, S., Rhodes, M.L., Dick, G., Sermpezi, R., *Impact Assessment Guidebook: Developing robust monitoring and evaluation plans for nature-based solutions*, Connecting Nature Grant Agreement number 730222, 2021.
- Ershad Sarabi, S., Han, Q., Romme, A.G.L., de Vries, B., and Wendling, L., 'Key enablers of and barriers to the uptake and implementation of nature-based solutions in urban settings: a review', *Resources*, Vol. 8, No 3, 2019, Art. no 121.
- European Commission, *Indicative Guidelines on Evaluation Methods: Monitoring and Evaluation Indicators*, Directorate-General: The New Programming Period 2007-2013, 2006.
- Faivre, N., Fritz, M., Freitas, T., de Boussezon, B., and Vandewoestijne, S., 'Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges', *Environmental Research*, Vol. 159, 2017, pp. 509-518.
- Falco, E. and Kleinhans, R., 'Digital participatory platforms for co-production in urban development: A systematic review', *International Journal of E-Planning Research*, Vol. 7, No 3, 2019, pp. 52-79.

- Follett, R. and Strezov, V., 'An analysis of citizen science based research: usage and publication patterns', *PLoS One*, Vol. 10, No 11, 2015, Art. no e0143687.
- Frantzeskaki, N. and Kabisch, N., 'Designing a knowledge co-production operating space for urban environmental governance—Lessons from Rotterdam, Netherlands and Berlin, Germany', *Environmental Science and Policy*, Vol. 62, 2016, pp. 90-98.
- Frantzeskaki, N., McPhearson, T., Collier, M.J., Kendal, D., Bulkeley, H., Dumitru, A., Walsh, C., Noble, K., van Wyk, E., Ordóñez, C., Oke, C., and Pintér, L., 'Nature-based solutions for urban climate change adaptation: linking science, policy, and practice communities for evidence-based decision-making', *BioScience*, Vol. 69, No 6, 2019, pp. 455-466.
- Galuszka, J., 'What makes urban governance co-productive? Contradictions in the current debate on co-production', *Planning Theory*, Vol. 18, No 1, 2019, pp. 143-160.
- Geneletti, D., Zardo, L., and Cortinovis, C., 'Promoting nature-based solutions for climate adaptation in cities through impact assessment', *Handbook on biodiversity and ecosystem services in impact assessment*, Edward Elgar Publishing, Cheltenham, 2016, pp. 428-452.
- Gilfedder, M., Robinson, C.J., Watson, J.E., Campbell, T.G., Sullivan, B.L., and Possingham, H.P., 'Brokering trust in citizen science', *Society and Natural Resources*, Vol. 32, No 3, 2019, pp. 292-302.
- Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J., Zaunberger, K., and Bonn, A., 'Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action', *Ecology and Society*, Vol. 21, No 2, 2016, Art. no 39.
- Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallop, G.C., Grubler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., O'Riordan, T., and Svedin, U., 'Sustainability Science', *Science*, Vol. 292, No 5517, 2001, pp. 641-642.
- Lodder, M., Allaert, K., Hölscher, K., Notermans, I., and Frantzeskaki, N., *Reflexive Monitoring Guidebook: using continuous evaluation techniques to adapt your nature-based solution planning process in real-time*, Connecting Nature Grant Agreement number 730222, 2020.
- Nesti, G., 'Co-production for innovation: the urban living lab experience', *Policy and Society*, Vol. 37, No 3, 2018, pp. 310-325.
- Pappalardo, V. and La Rosa, D., 'Policies for sustainable drainage systems in urban contexts within performance-based planning approaches', *Sustainable Cities and Society*, Vol. 52, 2020, Art. no 101830.
- Peter, M., Diekötter, T., and Kremer, K., 'Participant outcomes of biodiversity citizen science projects: a systematic literature review', *Sustainability*, Vol. 11, No 10, 2019, Art. no 2780.
- Raymond, C.M., Berry, P., Breil, M., Nita, M.R., Kabisch, N., de Bel, M., Enzi, V., Frantzeskaki, N., Geneletti, D., Cardinaletti, M., Lovinger, L., Basnow, C., Monteiro, A., Robrecht, H., Sgrigna, G., Munari, L., and Calfapietra, C., *An impact evaluation framework to support planning and evaluation of nature-based solutions projects. Report prepared by the EKLIPSE Expert Working Group on Nature-Based Solutions to Promote Climate Resilience in Urban Areas*, Centre for Ecology and Hydrology, Wallingford, 2017a.
- Raymond, C.M., Berry, P., Breil, M., Nita, M.R., Kabisch, N., de Bel, M., Enzi, V., Frantzeskaki, N., Geneletti, D., Cardinaletti, M., Lovinger, L., Basnow, C., Monteiro, A., Robrecht, H., Sgrigna, G., Munari, L., and Calfapietra, C., 'A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas', *Environmental Science and Policy*, Vol. 77, 2017b, pp. 15-24.
- United Nations, *Handbook on Planning, Monitoring and Evaluating for Development Results*, United Nations, New York, 2010.
- United Nations, *Transforming our World: The 2030 Agenda for Sustainable Development*. United Nations, New York, 2015.
- van De Gevel, J., van Etten, J., and Deterding, S., 'Citizen science breathes new life into participatory agricultural research. A review', *Agronomy for Sustainable Development*, Vol. 40, No 5, 2020, pp. 1-17.
- van Mierlo, B.C., Regeer, B., van Amstel, M., Arkesteijn, M.C.M., Beekman, V., Bunders, J.F.G., de Cock Buning, T., Elzen, B., Hoes, A.C., and Leeuwis, C., *Reflexive Monitoring in action. A guide for monitoring system innovation projects*, Communication and Innovation Studies, WUR; Athena Institute, VU, Wageningen/Amsterdam, 2010.
- Wamsler, C., 'Stakeholder involvement in strategic adaptation planning: Transdisciplinarity and co-production at stake?', *Environmental Science and Policy*, Vol. 75, 2017, pp. 148-157.

- Wamsler, C., Alkan-Olsson, J., Björn, H., Falck, H., Hanson, H., Oskarsson, T., Simonsson, E., and Zelmerlow, F., 'Beyond participation: when citizen engagement leads to undesirable outcomes for nature-based solutions and climate change adaptation', *Climatic Change*, Vol. 158, No 2, 2020, pp. 235-254.
- Xing, Y., Jones, P., and Donnison, I., 'Characterisation of nature-based solutions for the built environment', *Sustainability*, Vol. 9, No 1, 2017, Art. no 149.
- Zorita, S., García-Pérez, I., Murphy-Evans, N., Rödl, A., and Barone, E., *Deliverable 4.3 Monitoring strategy in the FR interventions*, Clever Cities, Grant Agreement number 776604, 2020.