UNaLab

URBAN NATURE LABS

Summary of Lessons Learned from NBS implementation

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About UNaLab

The UNaLab project is contributing to the development of smarter, more inclusive, more resilient and more sustainable urban communities through the implementation of nature-based solutions (NBS) co-created with and for local stakeholders and citizens. Each of the UNaLab project's three Front-Runner Cities – Eindhoven (NL), Genova (IT) and Tampere (FI) – has a strong commitment to smart, citizen-driven solutions for sustainable urban development. The establishment of Urban Living Lab (ULL) innovation spaces in Eindhoven, Genova and Tampere supports on-going co-creation, demonstration, experimentation and evaluation of a range of different NBS targeting climate change mitigation and adaptation along with the sustainable management of water resources. The Front-Runner Cities actively promote knowledge- and capacity-building in the use of NBS to enhance urban climate and water resilience within a network of committed partner cities, including seven Follower Cities – Stavanger, Prague, Castellón, Cannes, Başakşehir, Hong Kong and Buenos Aires – and the Observers, Guangzhou and the Brazilian Network of Smart Cities. Collaborative knowledge production among this wide network of cities enables UNaLab project results to reflect diverse urban socio-economic realities, along with differences in the size and density of urban populations, local ecosystem characteristics and climate conditions. Evidence of NBS effectiveness to combat the negative impacts of climate change and urbanisation will be captured through a comprehensive monitoring and impact assessment framework. Further replication and up-scaling of NBS is supported by development of an ULL model and associated tools tailored to the co-creation of NBS to address climate- and water-related challenges, a range of applicable business and financing models, as well as governance-related structures and processes to support NBS uptake. The results of the project will be a robust evidence base and go-to-market environment for innovative, replicable, and locally-attuned NBS.

Partners

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1. INTRODUCTION

During the UNaLab project, good practices, lessons learned and information about realised and potential barriers to the adoption of Nature-Based Solutions (NBS) have been collected. This information has been recorded into several UNaLab project documents. This document extracts some of the presented lessons learned and good practises concerning the NBS implementation to give a quick overview and starting point for this information. Additionally, it gives pointers to other UNaLab documentation, where the reader can find more information.

UNaLab project's Urban Living Labs (ULL's) have provided valuable data for municipal decision making and strongly supported NBS implementation, both for public and private developers and actors, when NBS actions have been replicated in UNaLab partner cities. Some NBS replication actions were inspired by the cities' own NBS actions, whilst others were inspired by NBS actions of other UNaLab cities.

Good practices help to replicate and accelerate the creation of NBS, but potential barriers can slow or prevent their implementation and should also be carefully taken into account already at the planning phase of the NBS project.

During the UNaLab project execution, information has been collected both from the FRCs and follower cities (FCs) about the potential barriers, which might inhibit NBS actions. Such barriers can be political, economic, social, technological, environmental, legal or ethical. Sometimes the observed barriers do not fall only into a single category, but the same or similar barrier may overlap several fields.

During the UNaLab project, it has been evident that the life cycle of NBS from co-creation to implementation and maintenance involves several stakeholders and multisectoral knowledge is needed. To ensure a successful result, knowledge and information transfer among actors and process phases is a key factor. **Error! Reference source not found.** highlight the information f low framework, which is proposed to be used in a NBS project at Tampere UNaLab Front Runner City (FRC).

In the following chapters, we outline first the general lessons learned and potential barriers encountered in the UNaLab project. Barriers are accompanied with some mitigation actions. This is followed by some specific examples from the project to give more detailed examples.

Main sources for this summary document have been the *UNaLab NBS Demonstration Site Start-Up Report* (deliverable D5.4) and the *Nature-Base Solutions Implementation Handbook* (deliverable D5.5).

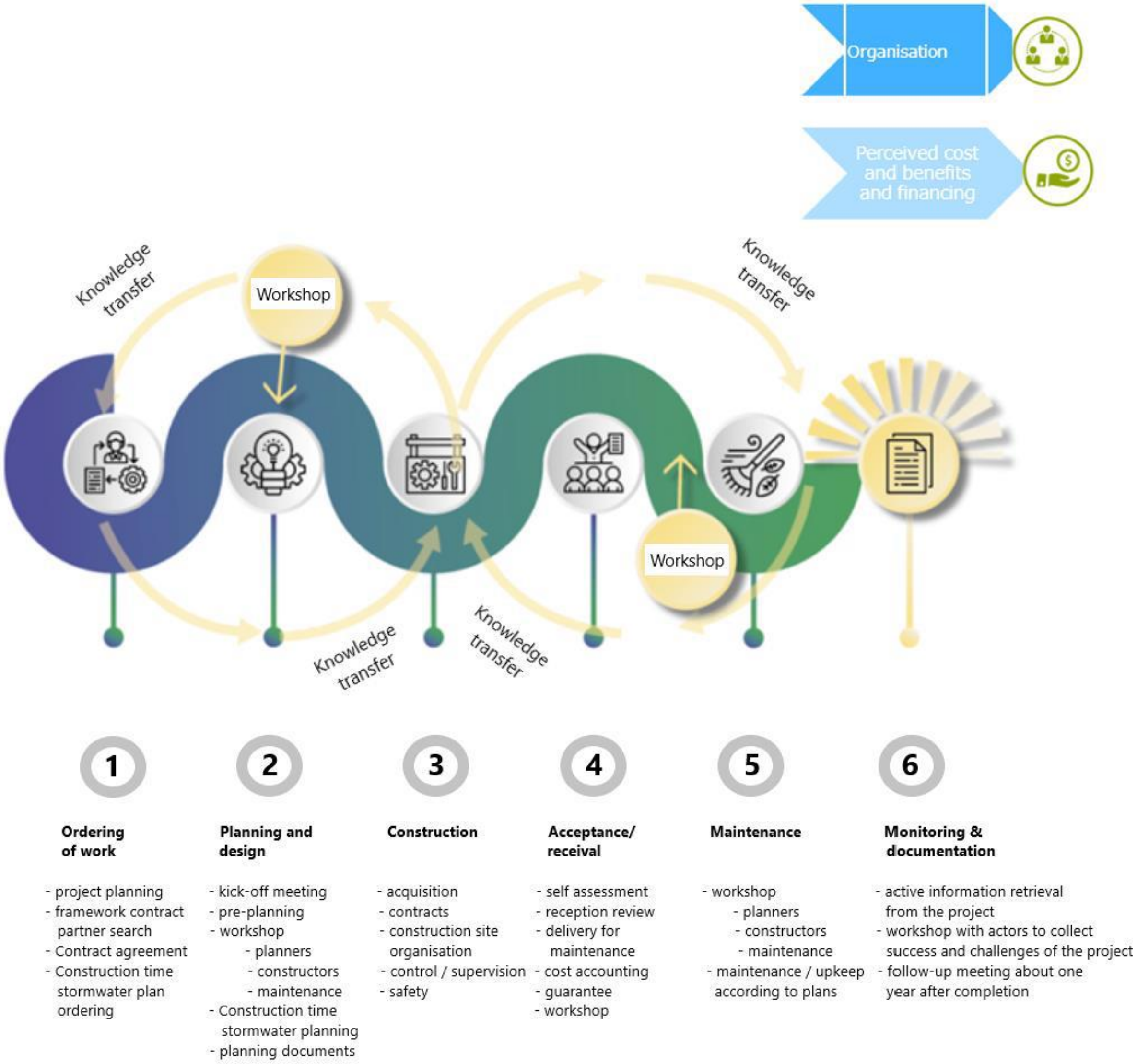

Figure 1 Importance of knowledge transfer in NBS project. Development of planning-implementation-maintenance chain of nature-based (storm water management) solutions (Luhtaniemi, 2020).

2. POTENTIAL BARRIERS PREVENTING ADOPTION OF NBS

In this chapter, we have summarised some of the observed barriers and mitigation measures found to overcome them in an effort to help other NBS actors avoid similar obstacles. This chapter can be used as a quick reference for the potential barriers. This chapter is based on the findings reported by all UNaLab partner cities, both the FRCs and the FCs.

2.1 Organisational barriers and countermeasures

As the concept of NBS remains novel to the general public, the lack of knowledge concerning NBS has been encountered as an organisational barrier to the adoption of NBS. Municipal structures are generally department oriented and groups or departments can be siloed to a greater or lesser extent, making it hard to co-operate. In contrast to this traditional municipal structure, multisectoral actions are needed to implement NBS. When NBS and their benefits are unclear, it can result in a lack of commitment among the requisite stakeholders. A lack of an innovation mindset can also sometimes be a barrier in municipal organisations with respect to NBS adoption.

The primary countermeasure to mitigate these barriers is to increase the knowledge regarding NBS and the awareness of their benefits. When positive experiences are gained around the implementation of NBS, initiating, up-scaling and replicating NBS will become easier in the future. Creating municipal guidance and a coordinated NBS implementation strategy is also recommended as a good practice. In addition, fostering co-operation among municipal departments should be enhanced to mitigate the silo mentality. Various national and international climate change adaptation and mitigation programs, along with sustainability, biodiversity enhancement and "greening" initiatives connected with a range of multi-level policy instruments support lowering of barriers associated with siloed organisational structures.

2.2 Social barriers and countermeasures

Similar to organisations, the lack of public awareness can also be a barrier to widespread NBS adoption. Although urban greening is almost universally viewed in a positive light, there are types of NBS that are less visible, making it harder to justify the need of them. In the dense urban areas with limited space, citizens might not appreciate Nature Based Solutions, if they would lose some of their achieved benefits, like parking places. Implementing Nature-Based Solutions can make the district more attractive impacting to rise of property prices and rents in the neighbourhood. Some can see this as a source of social inequality. Depending on the district socioeconomic problems, public policy priorities can higher in other fields than Nature-Based Solutions. Lack of public understanding of NBS benefits and insufficient practices of public participation at the local government level can in some cases cause false perception of NBS being an add-on option or greenwashing.

Lessons learned have shown that implementation take time and it is good to give people time to get use to new ideas and design. Public awareness about NBS is still quite low, so it is seen important to communicate actively about targets, what the city want to achieve with the NBS implementations. These actions can include e.g. public awareness campaigns and engaging schools to educate and participate in the process. Schools and organisations can be engaged to participate in the monitoring phase to see the functionality and assist municipalities via citizen science programs, but they can be exposed also to NBS already in the co-creation phase using UNaLab co-creation toolkit. To gain social acceptance, cultural heritage should be conserved, and programs should be inclusiveness oriented creating community spaces for all, not only for specific limited group of residents.

2.3 Legal barriers and countermeasures

Legislation guides many things in societies. On one hand it has been mentioned that there is weak support for NBS in legislation, but on the other hand, legal framework is seen complex. Despite NBS is not yet visible in legislation, other area legislation brings boundary conditions to NBS implementation. NBS implementation require changes into urban environment and many legal frameworks are concerned. Such areas are e.g. the cultural heritage, flora and fauna legislation, zoning plans, waterboard regulations and construction regulations. Procurement regulations for tendering can cause also extra challenges and acquiring necessary permissions can take a lot of time. NBS will be a local implementation, but national or province wide decisions can interfere with them. In the limited available area, ownership of land property can cause constraints to available implementation options or bring ethical or economical barriers involved in the process. Some people have also mentioned that lack of interdisciplinary standards can be a barrier. In case land expropriation would be needed, other barriers and considerations will be involved in the process.

To lower the potential legal barriers, liaising with legislature is seen important, because in the long run legislation can adapt better to take into account the requirements of NBS, when people with NBS knowhow are involved in the change process. It has been seen beneficial to start in time applying needed permission, because the approval process can be very long. Although NBS would not directly be mentioned in the legislation, the climate change mitigation and adaptation changes bring up the need for needed countermeasures, where NBS can be the answer. These include the e.g. the requirements for rainwater management or heat stress reduction in legislation for urban construction.

2.4 Ethical barriers and countermeasures

Although ethical barriers have not foreseen as major obstacles during the project for NBS, some potential barriers have been raised. Using public money to implement NBS on the private property might require ethical inspection. In the dense urban areas, available public space might not be sufficient for larger NBS implementations. Available resources are often limited, which require balancing between NBS and other investments. Some ethical issues can follow from designing the monitoring programs to ensure the functionality of the NBS and/or impact of the NBS, GDPR and privacy issues need to be taken into account e.g. when using cameras, surveys or other monitoring techniques, which could result to recognition of persons using the NBS.

2.5 Political barriers and countermeasures

Politics can bring uncertainty to the long term NBS implementation plans, because repeatedly occurring elections can both change the strategies in the municipal decision making, but also induce periods, when decision making is slowed down for a certain time. These can occur both before elections, when new bigger issues are not anymore decided, or after elections, when the new elected representatives are starting their term and concentrating to urgent pending issues. Politicians promote their own agenda and Nature-Based Solutions don’t necessarily have high priority in their program resulting to lack of political commitment or leadership for NBS the implementation or speedy adoption. Political decisions can also be connected to agreements and compromises between the institutions and parties in power and in opposition. Some decisions are politically hard to make. like less space for cars in favour of greening the city or land and site expropriation when there is not enough space for a certain implementation. Local authorities and politicians have to follow also national regulations and guidelines. Convincing other local and government authorities for land provisioning might be needed when available space is insufficient and agreements with private landowners is not possible.

Awareness about climate change adaptation is increasing, which starts to impact the politicians, who start giving higher priority to environmental issues. Despite this shift, the challenge is still to keep politician committed to NBS programs, when they face competing interests. Gradually NBS is moving to the long-term environmental plans in several cities and districts, which promise increase of NBS implementation in the future. When piloting and pioneering NBS in new areas, some of the cities have started with "easy to realize" projects and collected references from successful example projects to increase awareness and acceptance among stakeholders and inhabitants for the next larger NBS projects. Another channel to lower the political barriers is to lobby for changes in rules & regulations to enforce NBS and to turn NBS into a politically winning asset. As well as the implementation requires a project leader, a political project leader can assist the NBS promotion significantly. When the NBS awareness of the public increases, it reflects also to the politician awareness making attitudes towards NBS more favourable.

2.6 Environmental barriers and countermeasures

During the UNaLab project, project partners have encountered several environmental barriers, which delay or extend the implementation time of NBS much longer and increase severely the costs. In the worst case the barriers can even prevent the NBS implementation completely. These encountered barriers include among others:

- Polluted soil
- Archaeological findings
- Hidden war time explosives and ordnances
- Reconstruction of heavy existing infrastructure, like tram rails, sidewalks or streets
- Available space
- Conflicting objectives: more water elements to reduce heat island effect vs less water elements to avoid mosquitoes
- Danger of impact or contamination to the aquifer
- Local weather conditions, e.g. long dry periods followed by extreme rain periods
- Seasonal restrictions (e.g. winter in the Nordic countries vs. winter in Southern countries)
- Same NBS solutions don't always fit to other location, at least not without modifications.
- Some decision makers are expecting to have quantified environmental benefits of NBS to support their decisions.

To avoid these barriers, extensive surveys already during the design phase are needed for potential polluted areas, archaeological findings, cables and pipes etc. It should be still remembered that unexpected issues during the implementation can and most likely will happen and changes or delays to the implementation occur. Long term environmental programs and related city plans need to be connected together but changing priorities can result to swift decisions. E.g. in case some specific challenge emerges to be a risk factor. Different climate regions require sometimes also some adaptation and all solutions cannot be directly copied from another city or location. Education about NBS and how they work is needed to ensure successful implementation.

2.7 Technological barriers and countermeasures

As in many other barrier categories, lack of knowledge or experience is a barrier. Adding NBS to existing grey infrastructure can lead to unwanted side effects with air or water flow changes, either increasing or decreasing the flow. Different climate and weather regions require also different or adapted solutions and one solution, which fits everywhere does not exist. Lack of knowledge of successful NBS pilot projects in your own climate region keep municipalities careful. Access to and procurement knowledge of the multisectoral technologies are needed both in the buyer and provider side to overcome these obstacles. Some novel technological solutions might need further development or research which overlaps with the economic barriers, e.g. who is going to pay for the development, which later can be used by others. Examples of encountered challenges have been e.g.

- How to create a parc on top of an existing parking house
- How to green the façade of parking house
- How to repair a broken biofilter
- Improving soil conditions can be a big separate project and require special expertise
- What are suitable environments for biodiversity micro-organisms
- Lack of experience among NBS providers / not enough experts in the field of NBS
- Lack of experience, when scaling small scale NBS to large scale

Sometimes it has been found out that there is lack of commitment over the area once the project has been completed when the next instance should take over the maintenance responsibility. The technological benefits versus challenges have not always been fully tested (e.g., the robustness, mosquito issues, etc.) and more research about the NBS effectiveness, biodiversity benefits and hybrid solutions has been asked for.

Deliverable D5.4, the *UNaLab NBS Demonstration Site Start-Up Report*, reports several technological lessons learned, which has been gained from the UNaLab implementations concerning experienced difficulties and suggestions for improvements in certain NBS. Many quarters have demanded standards, manuals, and textbooks to be developed to better guide practices with proven sound NBS solutions. This document together with the D5.4 deliverable aims to provide answers to this gap from its own part. Involvement of universities and research institutes to educate students through learning about NBS to increase awareness has been also seen beneficial.

2.8 Economic barriers and countermeasures

Economic barriers are often tied together with the political and partly to the technological barriers, because they are tightly connected in the public domain. Funding is probably the most limiting resource drawing the border lines to what will be carried out. It is important to remember that implementation is not the only cost incurred from Nature-Base Solution, which need to be secured, but the whole lifetime of the NBS from design and operation up to the continuous maintenance including needed human resources. If the available space is too small, increasing the required space will lead to cost implications and can in some cases prevent the NBS implementation, because the space used for another use will provide better profit or benefits. Securing funding for the whole service life of NBS has been seen as a barrier. Economic challenges exist not only on the procurement side, but also on the production side. Stakeholders producing NBS (tools, services, etc.) need to have a sound business plan to justify their operations. Being a novel area, NBS has in some regions challenges to show the incentives or benefits, which can be acquired with NBS. Amount of skilled NBS personnel is still limited both on the provider and acquisition side causing bottlenecks for the projects and sometimes also increasing costs in a rivalry situation.

During the project good practises and lessons learned have been gained also to overcome the economic barriers. It has been said as a general comment that climate adaptation actions doesn’t have to increase costs, but especially in the transition phase cost often increase, because removing old structures can be very expensive as reported in the previous barrier chapters. On the other hand, the maintenance of the ready NBS can sometimes be more cost efficient than the maintenance of the old grey infrastructure. New stricter design requirements concerning the climate adaptation and climate change need to be taken into account in all new projects, which open the opportunity for the NBS to solve some of the existing challenges. Increase of NBS awareness and provision of incentives can assist the NBS adoption in larger scale. NBS can be implemented afterwards, but if there is the opportunity to include the NBS in the bigger scale project as an integral part already from the beginning, some of the potential barriers can be avoided. This will also ensure the budget allocations. Project management and division to well lead sub-projects with skilled professionals is one of the key factors for successful result. It should be remembered that some of the larger NBS design and implementation require multisectoral knowledge, which might not be found from the buyer's organisation or even from one solution provider. To gain economic acceptability, cost benefit analysis and comparison of NBS and grey solutions can be beneficial. Volunteer groups and public participation can be engaged in the projects both with awareness increase and using vouchers. Last but not least, public tendering in the bigger scale projects can bring additional challenges in the procurement of services.

3. Good practices and lessons learned from NBS implementation in UNaLab cities

This section describes and discusses successes as well as lessons learned from joint and local perspectives. General guidance is given to advance NBS implementation based on the FRCs' experience.

3.1 Joint outcomes

The project provided a priceless occasion for the different municipal agencies and departments to collaborate, and it highlighted the need to facilitate design processes with particular attention to the implementation of natural solutions for urban resilience. Table 1 lists the joint outcomes and lessons learned from three UNaLab FRCs under relevant categories, including building upon outcomes discussed in Hawxwell et al. (2018).

Table 1. Joint outcomes from NBS implementation in UNaLab FRCs.

Category	Joint outcomes
Public acceptance	• Citizens generally react positively to green spaces, but disseminating positive outcomes of NBS to citizens is valuable for attracting a wider audience • Awareness raising and dissemination among citizens aid in accepting less neatly looking areas (i.e., introduction of more natural habitats instead of regular lawns) • Citizens are willing to actively participate in co-creation and co-monitoring if tools and means of participant retention are carefully considered and applied • Sharing solutions with stakeholders is essential for creating a 'common vision' and a sense of involvement • Establishing joint initiatives (e.g., Communities of Practice or through other collaborative NBS effort) aid in overcoming reluctance to accepting NBS and establishing cohesion
Cooperation within and between municipal units and decision-makers	• Nature-based solutions offer an integrative direction for multidisciplinary cooperation, but the cooperation must be facilitated carefully • A multidisciplinary approach is critical for defining the most relevant solutions and identifying challenges at early planning stages • Aiding decision-makers in understanding the importance and value of adopting NBS facilitate the wider NBS adoption and acceptance • Land-use trade-offs
Financing & procurement	• Conflicts between parties should be anticipated at any stage of NBS planning and implementation • Private actors can be integrated into NBS financing, but it requires more careful planning and discussion among parties • It is critical to outline the expectations and fulfilment criteria between the parties, especially when involving private financing
Technical & construction considerations	• Technical-economic documentation helps selecting the suitable NBS instead of conventional technologies and approaches • Locally-specific NBS guidelines and good practices aid in selecting appropriate interventions • Evidence from the implemented NBS interventions should aid in the future design processes

	• Training technical staff on the use and value of NBS proved beneficial for planning and implementation • Certain NBS require considerable space for successful implementation and functioning, so involving a multidisciplinary planning team is critical • Green roofs and façades comprised one of the most demanding NBS to implement, so they must be subject to a more thorough planning and realisation, and cooperation between green and construction sectors
Monitoring & evaluation of monitoring outcomes	• Frequent monitoring aids in detecting issues in NBS functioning and supports in solving them • Monitoring provides information for the future planning and NBS value facilitating replication and upscaling • Division of responsibilities for NBS monitoring should be clearly emphasised during the planning stages • Interpreting monitoring data and outcomes may be challenging, so appropriate baseline data, evaluation techniques and expertise are required • Challenges in the evaluation of monitoring outcomes often relate to poor or non-existent reference data • Data management strategy and data governance should be defined during the planning stage. Ownership of data between municipal units generated via monitoring
Maintenance	• Need of maintenance should be emphasised, and maintenance responsibilities and their execution should be carefully considered at the early stages of NBS planning • Maintenance costs and implementation should be planned at the early stages of NBS planning and implementation • Regular maintenance provides greater and longer lifecycle of the NBS interventions
Policies and regulations	• Targeted tendering aids in attracting investors for urban zoning that supports NBS implementation • City zoning and a local master plan for urban development creates opportunities for integrating NBS in the urban planning and replication potential, including upscaling of NBS • Forthcoming and existing EU-level regulations, e.g., the EU Biodiversity strategy, creates opportunities for greater NBS integration in planning and implementation • Local incentives that support NBS integration could introduce supportive regulations • Mainstreaming sustainable development aids in greater acceptance and lesser administrative burden that limits wider implementation • Urban resilience strategies reflected in local master plans create a solid ground for incorporating NBS into local climate-change adaption strategies

3.2 Locally specific outcomes

3.2.1 City of Eindhoven

Nature-based solutions proved to be helpful to make the city more climate-robust and more liveable at the same time. During the construction of the NBS, the maintenance department has been involved to provide comments on the chosen solutions. This appeared to be a suitable approach because some improvements were made during the construction phase. For example, the soil in Eindhoven lacks sufficient infiltration capacity in some places, which complicates the growing of plants. Adding some extra organic material improved the vegetation development and growth, and it additionally resulted in an improved infiltration capacity.

At first, the shop owners disapproved the idea of planting trees in front of their stores. This was overcome by “planting” temporary trees in the shopping street, so citizens and the shop owners had an opportunity to adapt to the street trees and could observe the ways the public responded to the inclusion of trees. Most citizens prefer the green solutions, which form the greater part of the NBS interventions. Although some people expressed their dissatisfaction with urban greening, most people greatly appreciate the NBS and perceive them as enriching the city. A beneficial undertaking, which expanded the NBS acceptance, was to appoint ambassadors – people who are enthusiastic about NBS and urban greening. Creating a CoP to share ideas and successes helped NBS advocates in Eindhoven to support and inspire one another. Such allies were beneficial for spreading information about the purposes and implementation of NBS.

In certain cases, green façades and green roofs require extra considerations for their implementation. For example, the construction of one of the green façades required considerable time to evaluate means of its attachment to the building as it was constructed with concrete flaps in front of the building. The implementation of green roofs, particularity on existing buildings, was not straightforward for several reasons. One of the reasons includes the bearing capacity of the existing buildings, which may not be constructed to carry the additional load of a green roof. If a building was identified as a (municipal) monument, it added more complications for green roof implementation, especially if the building was situated in the city centre. However, more attention is attracted if a green roof can be combined with solar panels. Although there are currently relatively few applicable examples of combined green and solar roofs, future developments may further illustrate the added value of integrating green roofs with solar panels.

Green façades, pergolas and green roof require regular maintenance. An important question during green façade, pergola and green roof implementation included determining who is responsible for the maintenance and who pays. During the NBS design, the challenge is to keep the maintenance costs as low as possible. It was ascertained that one should not choose the fast-growing plants for a quick result but choose the slow growing plants instead as they typically require less maintenance.

Monitoring proved to be essential for demonstrating the ways NBS perform, and it additionally aided in convincing the colleagues and other parties about the NBS value and compelled them to consider way of improving the local NBS.

Incorporating private funds in an NBS project requires fine-tuning between the municipality and the private partners. It is critical to outline the expectations between the parties. Due to the municipality regulations, which include the procurement rules, the timeframe for a municipality to realise an NBS project is different from that of an entrepreneur, and that must be considered during the planning stage.

3.2.2 City of Tampere

Co-creation and planning of NBS

In the City of Tampere, mutual learning was the most important objective and achievement of co-creation because it enabled equal encounters between the participants. Making mutual learning an objective provides space for managing the complexity of NBS. If co-creation focuses greatly on practical implementation planning, experts' views become relatively more emphasised, and citizens' views marginalised. Meetings of urban planners (experts) and citizens on site (NBS sites and the whole residential area) were fruitful and served to develop a common understanding and commitment. An additional learning point was that giving more space and power to other actors than municipality can result in interesting and surprising new ideas of ways to bring more nature to the city.

In practice, experimenting with novel solutions and resident participation works best for small sites and relatively small groups. Trying to get a very large group of individuals engaged hinders realisation of the demonstrations. In this kind of multiphase interactive planning, lack of resources is challenging. However, in this case, UNaLab project resources enabled various Living Lab activities that are not normally possible with municipal funding. Giving more power to other actors than municipality has the potential to save municipal resources, but one needs to be careful with equality and fulfilment of municipal democracy.

To improve detailed/implementation planning of the complex NBS, which require multi-sectoral knowledge, Tampere proposed the process presented earlier in this document in Figure 1. Process development targets to information exchange between various actors and phases (planning – implementation – maintenance). It is important to visit the NBS site (1 year) after the implementation and examine whether it performs as planned. It is equally important that planner and implementer communicate during the realisation to see whether the plans need to be adjusted due to circumstances on site.

Demonstrations and supportive actions in Vuores: Biofilter, retention pond, alluvial meadows, nature trail and information signs

NBS for stormwater management – biofilter, retention pond, alluvial meadows – in Vuores were the most straightforward demonstrations in Tampere, because the city has experience with similar NBS, and they proved to be reliable. The planning process was smooth as these NBS were already considered the adequate solutions especially in greenfield development.

Co-creation in Tampere highlighted the possibility for an accessible local recreation and awareness raising regarding NBS and biodiversity. As a result of co-creation, duckboards to make a nature trail more accessible and information signs were added to Tampere's demonstration plans.

Reflections:

- The decentralised, hybrid (grey, blue and green infrastructure) **stormwater management system of Vuores performs well for retention and purification of urban runoff**, and it will perform at the same level when Vuores has expanded to its full size (5 000 residents at present, and projected 14 000 more in the future).
- Original aim of the Vuores project to maintain the areas' moisture conditions has been achieved.
- These kind of **NBS require space**, which was not problem in Vuores, but could be an obstacle in more dense urban areas.
- **The Vuores school is built very low and there is risk of water damages at times of flooding**. School area is continuously kept dry by pumping water from school grounds to Virolaistenoja ditch.

- **The interpretation of water monitoring data is challenging** as the Vuores stormwater system is complicated and runoff passes through a small lake at one location. Therefore, it was challenging to determine a starting point to measure quantity and quality of the incoming water.
- Comparing water quality before construction of the stormwater management system to the quality after the system was built is misleading, because changed soil masses (swamp to rock) during the area construction might have resulted in clearer waters, upon which NBS might have less impact.
- When co-creating multifunctional NBS, **residents highlight access to nature** near their homes.
- The UNaLab project showed that residents in Vuores did not fully understand the multifunctional NBS in the area. The idea of stormwater retention and purification as well as biodiversity aims were not clear, and therefore acceptance of "new urban aesthetics" such as meadows and bushes instead of grass and neat garden was not as high as it could have been.
- The UNaLab project has been successful in **awareness raising** via Living Lab activities and information signs.

Small-scale NBS (innovation voucher funding, Vuores)

Three small-scale NBS projects were awarded innovation vouchers in summer 2019 by the City of Tampere. Two of the vouchers were used to develop garden areas near residential housing whilst the third voucher was used for the creation of a community horse park in the Vuores Central Park.

The innovation vouchers represent an interesting approach to enable residents to co-design and co-implement small-scale NBS. Through this initiative, encouraged citizens to take the initiative to plan and implement the NBS that they find useful for their environment. The city organised an official information session for interested citizens and the information was also disseminated through the city's communication channels. Three applications were received, and all the applied projects were funded.

The garden areas funded by the innovation vouchers implemented trees and bushes, planter boxes for the residents to use, fruit trees and berry bushes, perennials and summer flowers, as well as areas to compost gardening waste and structures to harvest rainwater for garden irrigation. The aim was to create safer, more inclusive and pleasant, and more communal areas for all residents to use and enjoy.

The residents of the buildings adjacent to the garden areas did most of the work themselves and used the funds from the innovation vouchers to purchase materials and transportation services needed for the construction work. Both housing cooperatives were very pleased with the end results and agreed that these collective projects have further enhanced the relations between the residents.

The third innovation voucher was used to establish a community horse park in the Vuores Central Park managed by the local Annisto stable. The horse park represents an example of how a green space can be managed for multipurpose use. The aim of the horse park is to promote citizen engagement (social wellbeing) in a natural setting and encourage outdoor recreation, while enabling residents to participate in and learn about the cultural heritage of the Vuores area. The horse park aims to increase residents' accessibility to outdoor activities, which otherwise may not be within their reach due to financial or social reasons. Interaction with horses has also been shown to enhance residents' well-being and general health, which was one of the objectives of the horse park. The UNaLab partners will continue to examine land use and management impacts on biodiversity in this multi-use green space.

The inclusion of innovation vouchers in the Tampere NBS business model proved a successful approach and solution to engage citizens to a greater extent in the city's efforts to implement NBS and supporting measures. This solution can easily be replicated in other cities or contexts, where small- or medium-scale NBS are implemented.

Reflections:

- Innovation vouchers **encourage residents and other city actors** than municipality ideate and implement novel nature-based solutions in the city.
- Nature based solutions created were **feasible: DIY-type** rather than professional/engineered solutions.
- Participants enjoyed working with neighbours – **social aspect** was highlighted.
- Living Lab was a new area and there were little applications received. In the future, **targeting such funding to older/more dense areas** with less nature and resources is recommended.

Biofilter for seepage waters

In autumn 2018, Tampere Infra constructed a biofilter at Hiedanranta to clean strong leachate (containing mean N_{tot} = 22 mg/L and P_{tot} = 0.9 mg/L) from the old pulp mill landfill. The landfill leachate is filtered through an area of ca. 100 m^2 and 3 m deep consisting, for example, of biochar, peat and expanded clay aggregate. Deep-rooted bushes and perennials native to the area were planted on top of the filter to retain water and nutrients. For the removal of odours caused by the water from the landfill, an activated char filter was installed on the manhole cover.

The biofilter was not included in the original project plan but was co-created with stakeholders during the project. The reasons behind the initiative include the city's intent to develop the qualitative management of stormwater, the reports of disturbing odours from users of the area and the interest of a biochar factory in Hiedanranta to promote the use of biochar in stormwater management.

After the co-creation events, a wide group of experts with expertise in water treatment and/or challenging demonstration site, continued demonstration planning. A shared vision formed around the demonstration, even though some contradictory views and interests were also highlighted. For example, the Centre for Economic Development, Transport and the Environment highlighted the need to treat all seepage water from the landfill, while the demonstration filter was planned only for half of the landfill and waters. The biochar manufacturer would have preferred to use iron-biochar to achieve the best possible cleaning result and to have a reference case, whereas Ramboll, who was responsible for the implementation plans, estimated basic biochar to be sufficient as part of the other structure. These are examples of the conflicting views regarding NBS, which complicate addressing the complex environmental problems in multi-sectoral cooperation. While NBS offer an integrated approach, the cooperation between parties must be carefully facilitated.

Initially, the biofilter seemed to function effectively in cleaning the landfill leachate (N removal 90% and P removal 60–70%), but capacity problems soon became evident. Monitoring revealed that the efficiency decreased, and nutrients began to leach from the filter to the lake. In addition, a greater share of urban runoff from the upstream catchment area was entering the filter than was estimated based on historical stormwater network data and previous flow rate measurements. Subsequently, overflowing runoff water bypassed the filter and entered the lake directly.

The first improvement was to channel the large share of urban runoff past the filter into a nearby stormwater basin. The next problem was leakage, which was noticed as the volume of filter effluent was four times greater than the measured filter inflow. In other words, large portion of inflow was entering the filter from underground, although the filter's bentonite layer was supposed to make it waterproof. At the same time, traces of bentonite started to appear in a post-filter monitoring well. After the leakage detection, it was not possible to evaluate the leachate purification performance of the biofilter as it was impossible to determine the quality of the incoming water from underground and thus calculate influent nutrient loads. Isotope analyses demonstrated that leaking water is rainwater, rather than lake water or groundwater. The observed capacity issue reflects well the complexity of NBS. In this case, monitoring has been invaluable in detecting and diagnosing the problems.

Some issues arose during the construction of the biofilter, and better exchange of information between the constructer and planner at early stages may have helped to avoid the resultant performance issues, e.g., by making changes to implementation plans. When construction was finished at the edge of the landfill, the excavations revealed car tyres and contaminated soil. Landfill gases and low oxygen content prevailed at the worksite and measuring wells, which resulted in health check-ups and the use of protective equipment at the building site and while working in the measurement wells. Installation of an insulating mat in the foundations failed the first time and had to be re-done. Leachate from the old landfill accumulated in holes on the worksite, and removal of the leachate by pumping slowed the construction work. It is important to leave space for learning in such demonstrations. Repair rounds are common in trials of innovations, but they are highlighted even more with NBS that exhibit performance issues and are co-managed by multiple stakeholders.

Reflections:

- Biofilters utilising novel filtering materials to purify landfill leachate is a good example of a **complex nature-based solution** where the implementation requires the use of multidisciplinary expertise.
- Nature-based solutions offer an integrative direction for **multidisciplinary cooperation**, but the cooperation must be facilitated carefully.
- In a **real-life context**, water flow analyses contain uncertainty.
- Biochar has potential to remove nutrients.
- Nutrient rich waters can cause biofilm growth and subsequent filter blocking.
- When biochar is used as filtering material, the fine fraction of biochar needs to be removed to mitigate clogging issues.
- **Frequent monitoring** detects problems and supports the diagnosis and resolution of issues.
- The landfill site turned out to be very **challenging site** for a large-scale underground biofilter pilot. Performance impacts and possible problems would have been easier to observe and solve if visible in, e.g., a container type reactor.
- **More R&D and experimentation is needed** with dedicated partners to demonstrate the long-term reliability of engineered NBS, including nutrient attenuation capacities of filter materials under changing environmental conditions (e.g., pH, oxidative-reductive potential, temperature, or other).
- If these kinds of systems are proved to be reliable, **scaling and replication potential** is high (e.g., for closed landfills and to support wastewater treatment).

Microalgae pilot (Hiedanranta)

This was an unusual demo, which was closer to research than the other "close to urban development" demonstrations in Tampere, because the local university was responsible for operating, monitoring and assessment. The aim was to create NBS for sustainable urban development in the future city district (and current ULL) of Hiedanranta. In this case, UNaLab was one of many projects supporting the microalgae demonstration in Hiedanranta. The demonstration was built and initiated with the UNaLab resources, and other funding sources supported the work of researchers on the site to operate and monitor the performance of the microalgae pilot. Due to the close cooperation with academia, the results of this demonstration are published in peer-reviewed scientific journal articles.

In their publication based on the microalgae pilot in Hiedanranta, Chatterjee et al. (2019) highlight that "[h]uman urine contributes approximately 80% of nitrogen and 50% of phosphorous in urban wastewaters while having a volume of only 1-1.5 L/d per capita compared to 150-200 L/d per capita of wastewater generated". This alone has led to global interest in source separation of urine and the development of efficient and economical methods to recover nutrients from urine. In the microalgae pilot in Hiedanranta, nutrients from source separated urine were used for outdoor cultivation of microalgae in a Nordic climate. The freshwater green microalga *Scenedesmus acuminatus* was grown in different dilutions of source separated human urine, in a semi-continuously operated outdoor raceway pond. The microalgae were able to remove 52% of the total nitrogen and 38% of the total phosphorus from source separated urine under the experimental conditions applied, even at culture temperatures as low as 5 °C (Chatterjee et al., 2019).

Green wall (City centre)

Since 2017, it has been a great effort to integrate a green roof and/or wall demonstration to one of the building construction projects in Tampere. Although during the years, plans have changed many times, the implementation of a green wall was implemented as the UNaLab demonstration in 2021–2022. In addition to the green wall, a green roof will be implemented later by the City of Tampere (Water Utility). Although the construction of the green roof will happen after the project end, the UNaLab project has had a great impact on the green roof plans. The green roof will be a meadow type (enhancing biodiversity) with a 10 cm layer (providing water retention) of recycled soil (targeting carbon emissions).

The green wall/roof demonstration was first initiated in the Living Lab Hiedanranta, as the initial plan was to demonstrate a green roof on one of the old industrial buildings in the brownfield area. At first, the old Hiedanranta water treatment plant was selected as a suitable building for the green roof demonstration. This was one of the oldest buildings in the area, at risk of collapsing and thus in need of renovation. Preliminary plans for a garden roof and a cost estimate were prepared for the site. Then, the city received an offer to buy the water treatment plant and the green roof plan was abandoned. Thereafter, preliminary plans and cost estimates were done for two more old halls in the area. However, the conclusion was that it is too expensive to build a green roof on the old factory buildings in Hiedanranta, because it would have meant demolishing the old roof and building whole new roof that can support the additional weight of a green roof. The lack of plans for future use of the brownfield buildings hindered green roof implementation in Hiedanranta.

Then, in spring 2019, after multiple-stage negotiations, the officials from different units of municipality decided to add a green roof demonstration to the project plan for the service building of the Kauppi outdoor recreation area. The service building was a suitable pilot site because it will be heated similarly to residential buildings but visits to the building will be of short duration. A heated building would be a step forward from green roofs of carports which are already a common feature in Tampere. People stay in the changing rooms of the service building only for a short time, which made the risks associated with a green roof acceptable, namely building humidity and air quality problems. In addition, the construction timetable of the service building fitted the UNaLab project. In the end, this demonstration was rejected by municipal decision-makers in autumn 2019. The green roof was removed from the plans of the service building because it was deemed expensive and remote. However, well-prepared plans for the green roof advanced the public discussion and leaders promised to locate better sites for green roofs in Tampere.

Finally, the suitable demonstration site was found slightly outside the core city organisation. The Water Utility of the City of Tampere is currently constructing new wastewater treatment plant (WWTP) outside the city centre. The old WWTP located in the city centre (Viinikanlahti) will be closed and replaced by a large wastewater pumping station (900 m^2) surrounded by a dense city district. The design requirements for a pumping station were high, because it will be located in the middle of the apartment buildings and along an ecological corridor and walking/bicycling path heading south from the city centre. The “City landscape board” decided that a green roof and wall are obligatory for the building project. Municipal staff from the UNaLab project then became involved with the planning of the pumping station and incorporated green roof and wall plans together with other planning. However, the implementation was shifted somewhat because the pumping station construction was delayed beyond the UNaLab project timeframe. The solution was to build a modular green wall in a temporary location (old WWTP) and monitor it. When the pumping station is constructed, the wall will be relocated to the station and the Water Utility is building a green roof as planned by the UNaLab partners.

Reflections on the planning phase:

- Green roofs/walls are the exceptionally demanding pilots because they require **cooperation of green and construction sectors**.
- The building sector is used to diverting water away from buildings and the **idea of ‘wet soil on a roof’ is not easily accepted.** There are concerns that construction mistakes such as leakage are hidden under the soil and moisture in the building structures will cause indoor air quality problems.
- It is important to create a **shared vision and engage all key stakeholders before the NBS project starts.**
- The City of Tampere is now considering making **a green roof strategy** to systematically guide green roof/wall implementation.

3.2.3 City of Genova

The requalification of the former Gavoglio barracks area comprised a new connection of the area of the former Gavoglio barracks to the neighbourhood as a potential **urban hinge** between the landscape system of the historic forts and the dense urban context of the consolidated city. The project site thus became a demonstration for a redevelopment strategy that combines the recovery of historical heritage and the creation of new connections with the Lagaccio district (in relation, for example, to the historical roots of the “crose”) for the reintegration and enhancement of the former barracks. The increased connectivity through redevelopment at neighbourhood level triggers processes to limit the strong social contrasts present in the Lagaccio neighbourhood, characterised by problems deriving from low-middle income population and immigration.

The creation of new **green infrastructure** is an opportunity for the highly urbanised Lagaccio neighbourhood to re-establish ecosystem services and enhance the quality of the urban environment, and to promote new community green spaces for socialisation, such as an urban orchard. Different species of bushes and trees (including varieties of oak) could be found in the area before the start of the project; however, they were very poorly maintained. The city aimed to preserve the already present native species with gradual thinning and adoption of a naturalistic forestry approach without unnecessary vegetation replacements. The expectation was for a gradual recovery of the local ecosystem, particularly in terms of pest control and limiting the presence invasive species. The increase of green surfaces and tree-lined spaces, with consequent reduction of the impermeable surface areas, allowed increasing the environmental protection of the area by reducing the hydrological risk and by increasing the geotechnical stability of the slopes, allowing for groundwater recharge and providing stormwater storage capacity in a large drainage area. The constrained watercourses in the underground pipes was addressed, and this will consequently reduce the reliance solely on conventional sewer type infrastructure to ameliorate flooding and landscape instability phenomena along the Lagaccio river basin as a result of the increasingly frequent heavy rainfall events. The resulting damage to buildings and people will also be reduced in central city districts. The recovery and reuse of rainwater reduces the use of groundwater for irrigation purposes, enhancing water security. The increase of green areas and trees favours the reduction of atmospheric pollutants, supporting carbon sequestration and a subsequent improvement of the local microclimate, contributing to the overall reduction of urban temperatures.

Indicators for the quantification of expected benefits:

- Increase in green and blue space (ca. 2 754 m^2)
- Reduced stormwater runoff (ca. 31%)
- Increased carbon sequestration
- Demolition materials reused on site (ca. 4 925 m^3)
- Biodiversity increase (based upon numbers of native/naturalised species)

The increased **accessibility and inclusiveness** of public (green) spaces is aimed at solving the issues that currently characterise the area, addressing the fragmentation and inadequacy of the road network, improving pedestrian mobility, and promoting slow mobility to the detriment of vehicular mobility. The result is the creation of inclusive, multifunctional, and flexible public spaces that are suited to the topography of the area, create an interruption to the excessive residential urbanisation and increase the attractiveness of the area, making it a strategic hub between the “Piazza Principe” station to the south and the “Parco dei Forti” to the north.

Indicators for the quantification of expected benefits:

- Increased area for pedestrians (ca. 124%)
- Increased access to urban public outdoor recreation space (ca. 5 313 m^2)

4. LESSONS LEARNED FROM THE NBS MONITORING AND IMPACT ASSESSMENT IN UNALAB CITIES

NBS are associated with distinct impacts on ecosystem services and improvement of a range of environmental aspects hindered by urban growth. However, a selection of NBS to address the identified challenges and pressures should prove its impact and indicate whether the anticipated outcomes are achieved, including monetary and environmental targets, to consolidate the future investments into wider NBS implementation. Monitoring is one of the central factors determining the success of the NBS impact assessment as it provides quantitative and qualitative evidence of the impact generated by the NBS interventions

Monitoring and impact assessment of NBS comprises several steps that are equally important for the development of a holistic monitoring and impact assessment strategy. NBS impact assessment framework is the essential step when targets and objectives are evaluated against the measured performance during the NBS monitoring stages (Figure 2). Impact assessment identifies causalities and aids in determining the supporting or additional interventions necessary for achieving the goals. This makes the NBS implementation process cyclical enabling the adaptive management cycle of every NBS project.

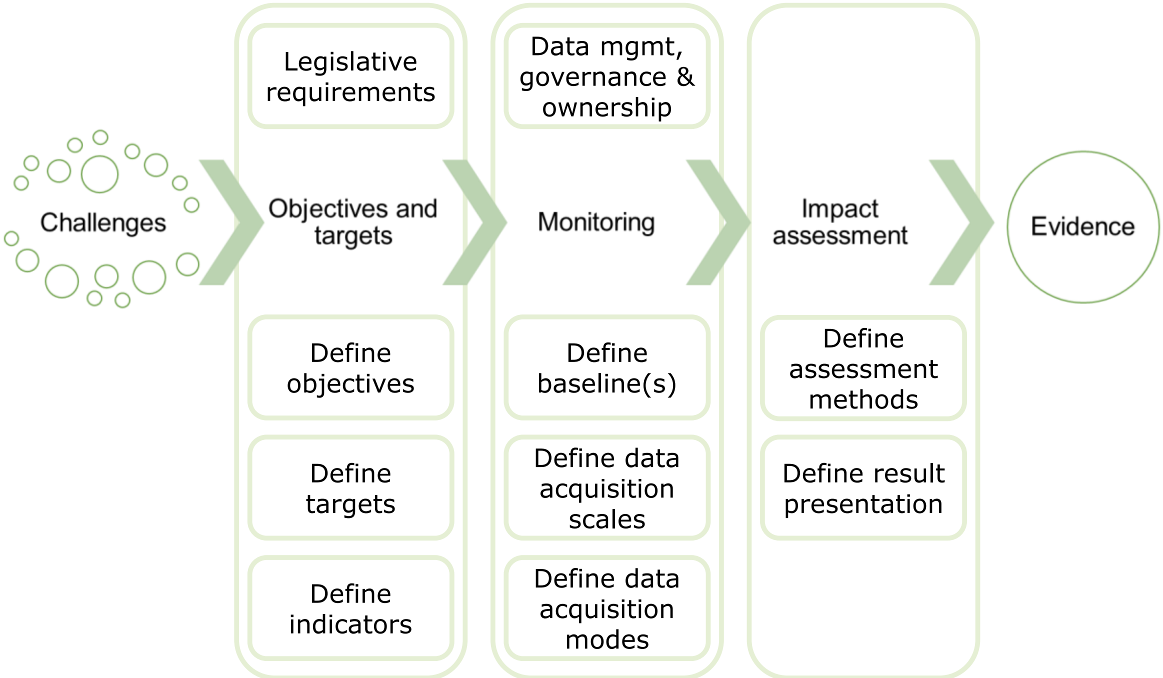

Figure 2. Framework for co-definition of NBS performance and impact indicators and assessment protocols (based on Dubovik et al., 2020).

The co-developed monitoring and impact assessment scheme applied in front-runner cities, has been continuously evaluated using various sociocultural approaches (including questionnaires, interviews and focus groups) to assess the understanding of stakeholders at different stages of the project to map the evolution of stakeholder perspectives on the performance and impact of NBS in the face of global change. Based on the critical evaluation of the monitoring and impact assessment scheme, several solutions to the raised issues have been co-identified with the corresponding stakeholders. The solutions aim to optimise stakeholder ease-of-use and cost-effectiveness as well as streamline data collection. The results are summarized in Table 2.

Table 2. Stakeholder evaluation of the co-developed and applied monitoring and impact assessment scheme and solutions to address the challenges.

Stage	Challenge	Solution(s) provided
Key performance indicators	• Co-identification of possible NBS performance indicators time-consuming • Vast number of available indicators complicates selection of key performance indicators	• Prior to starting the discussion with stakeholders, it may be beneficial to limit the number of indicators by assembling a local expert group, which is familiar with the local challenges and pressures and that recommend a narrowed list to further the discussion
Baseline or no-NBS assessment	• Appropriate baseline data is needed • Appropriate baseline data is often hard to obtain (pre- or no-NBS)	• Early identification of NBS site such that monitoring can start well before implementation • If resources allow, combine before/after and project/control site set-up such that exogenous factors can be corrected for • If resources allow, compile and use data from different sources at various scales • Use monitoring and modelling to establish baseline • Hire-in experts to aid in or perform the establishment of the baseline
Scale of NBS impact	• Defining the appropriate granularity of measurement is complex	• Perform literature/document review to identify recommended granularity for similar interventions • Assemble a local expert group, which is familiar with the scale of local challenges and pressures • If, however, impacts are yet unclear and resources allow, compile data at various scales • Hire-in experts to aid in or establish the appropriate granularity
Acquisition mode	• Frequent monitoring aids in detecting issues in NBS functioning and supports in solving them • Selecting the appropriate type and quantity of equipment is complex • Defining the appropriate means of measurement (e.g., placement) is complex • Performing monitoring activities by municipalities difficult to reconcile with normal duties of staff	• Hire-in experts to aid in or perform purchasing, placing, operating and maintaining monitoring equipment
Evaluation framework	• Monitoring provides information for future planning and NBS values facilitating replication and upscaling • Appropriate evaluation techniques and expertise are required	• Use monitoring and modelling to assess NBS impacts • Hire-in experts to aid in or perform NBS impact assessment

	• Assessment of multiple impacts through modelling complex (data; scale; models)	
Other	• Challenges in choosing and establishing NBS project areas • Division of responsibilities for NBS monitoring and impact assessment not always clear • Exogenous changes in the environment (e.g., changes in traffic conditions; COVID-19) complicate monitoring and impact assessment of NBS • Data management strategy and data governance not always clearly defined • Ownership of data across municipal units generated via monitoring	• Division of responsibilities for NBS monitoring and impact assessment should be clearly defined during planning stages • Data management strategy and data governance should be defined during the planning stages

Selection of key performance indicators

The first thing to note is that choosing and establishing NBS in the front-runner cities (FRC) was complicated, due to many practical challenges and occurrences – such as bureaucratic processes (internal agreements; permissions; tendering), non-cooperating third-parties and stakeholder opposition as well as difficulties in finding contractors (i.e., NBS not core-business), 'surprises' during the establishment of the NBS (e.g., pollution in the ground) and delays (e.g. due to COVID-19).

In UNaLab the identification of possible indicators and the selection of key performance indicators was established in a co-creation process such that stakeholders would acquire ownership of what could and should be measured. While this was generally appreciated by stakeholders, it was also a tedious and time-consuming process – requiring joint workshops, bi-lateral meetings and written feedbacks. This resulted in the identification of a large number of possible indicators from which, in turn, key performance indicators (KPIs) needed to be co-selected. While this seemed relatively easy at the start (ambitious stakeholders), the consequences of selecting a specific KPIs were yet unknown (i.e., requirements regarding baseline, scale, acquisition, evaluation and other). Therefore, over the course of the project KPIs had to be re-visited due to challenges encountered in the following stages.

Once the NBS have been clearly defined (i.e., objectives, type and location of NBS), the co-identification and selection of KPIs would be greatly facilitated by preparing a reduced list of most relevant indicators prior to starting the discussion with stakeholders. The list of most relevant indicators can be assembled by a local expert group, which is familiar with the local challenges and pressures as well as the expected impacts (types; scale) of the proposed NBS. Hence, stakeholders can more quickly decide on the KPIs to be adopted as well as discuss potentially missing indicators.

Baseline establishment

Once the KPIs were selected, appropriate baseline data (pre- or no-NBS) needed to be collected. Pre-NBS baseline data was generally hard to gather due to the abovementioned challenges in selecting and establishing NBS in the FRCs, resulting in uncertainty in where to measure what. In addition, stakeholders expressed their concerns regarding the suitability of obtained pre-NBS/post-NBS data, associated with changed exogenous conditions (such as changes in traffic conditions and COVID-19). No-NBS baseline data required the identification of an appropriate control-site (hard to find in practice) and implied the purchase of additional monitoring equipment (not only for NBS-site but also for control-site).

Establishment of a proper baseline for comparison is a crucial but not straightforward task. Establishment of a pre-NBS baseline requires the NBS and associated indicators to have been clearly defined before the actual implementation of the NBS; monitoring will then start before NBS implementation and continue after NBS implementation. Hence, a pre-NBS baseline can only be established when the NBS and associated indicators have been defined well before NBS implementation.

Establishment of a no-NBS baseline requires the NBS and associated indicators to have been clearly defined such that a suitable reference site can be identified; monitoring will then occur simultaneously across the NBS and no-NBS sites. Hence, a no-NBS baseline can be established even after NBS implementation. If resources allow, combine pre-NBS and no-NBS baselines (such that exogenous factors can be corrected for) and make use of data from different sources at various scales (such as regular monitoring or remote-sensing data). Besides monitoring, also modelling can be used to establish pre-NBS and/or no-NBS baselines. Given the complexity in establishing baselines, be it based on monitoring or modelling, it is recommended to hire-in experts to aid in or perform the establishment of baselines.

Monitoring and data collection

Defining the appropriate granularity of measurement (i.e., spatial density and temporal frequency of measurement) was also considered complex as it was yet unclear at what spatial and temporal scales the impact of NBS could be measured. Data acquisition resulted to be most challenging. Albeit considered crucial in detecting and resolving issues in NBS functioning, the selection (type; number; calibration) and placement (sun/shade; in/near; height) of equipment was considered complex. In addition, monitoring implied additional work for staff at the municipalities (non-automated monitoring; maintenance monitoring equipment; detecting and resolving issues) on top of their normal duties.

Defining the appropriate scale of NBS impacts is, also, not a straightforward task as it depends on the type, size and location of the NBS. It is suggested to perform a literature/document review (to identify recommended granularity for similar interventions) as well as to assemble a local expert group (that is familiar with the scale of local challenges and pressures) as to define the appropriate monitoring scales (i.e., per indicator). Otherwise, data need to be compiled at various scales – which is costly. Defining the mode of acquisition (selection, placement, operation and maintenance of monitoring equipment) is a highly specialized job. Again, it is recommended to hire-in experts to aid in or establish the appropriate granularity and to aid in or perform purchasing, placing, operating and maintaining monitoring equipment. Data ownership, management and governance should be defined during the planning stages.

Evaluation framework

Evaluation of NBS impacts was considered crucial as it provides information for future planning and NBS values that facilitate replication and upscaling. It does, however, require appropriate evaluation techniques and expertise and is, also, time-consuming. Where NBS impacts were assessed through modelling, multiple complex models needed to align (data; scale) to assess the multiple impacts of a wide range of NBS (from small NBS interventions to city-wide NBS implementation) – stretching the boundaries of currently available models.

Evaluation of monitoring and modelling data to assess the impact of NBS is, once again, a crucial, non-standard and time-consuming task. Also, here it is recommended to hire-in experts to aid in or perform the NBS impact assessment.

Other challenges

Finally, and as far not mentioned before, other challenges included unclear division of responsibilities for NBS monitoring and impact assessment as well as unclear data management strategy and data governance. It was, however, mentioned that ownership of data across municipal units was promoted via monitoring. Therefore, it is crucial that the division of responsibilities for NBS monitoring and impact assessment is clearly defined during planning stages.

5. CONCLUSIONS

This document provides a quick overview to the UNaLab project lessons learned and barriers encountered during the project.

E.g. lack of knowledge concerning NBS has been encountered among many stakeholders and interest groups, and it propagates to many areas causing challenges to implement NBS. Promotion, education, and awareness raising campaigns, which UNaLab partners have been actively executing lower this obstacle, but it is a lengthy process and one project cannot change the world in one night. Another encountered challenge has been that the municipal structures are often department oriented and groups or departments can be siloed to a greater or lesser extent, making it hard to co-operate.

Lack of NBS knowhow results also at the moment to the situation that it can be a challenge to find enough skilful providers or personnel for complex and/or large NBS projects.

In the municipal environment, political barriers and challenges cannot be underestimated. Politics can bring uncertainty to the long term NBS implementation plans, because repeatedly occurring elections can both change the strategies in the municipal decision making, but also induce periods, when decision making is slowed down for a certain time. Politics is also tied closely to the economics, which is a limited resource and NBS need to compete with many other investments in the decision-making processes. With NBS, public-private partnerships and cooperation is often needed, and divergent interest priorities can cause challenges or delays to the NBS implementation or in the worst case even prevent them.

Monitoring and evaluation of NBS impacts has been considered crucial as they provide information for future planning and NBS values that facilitate replication and upscaling. They do, however, require appropriate evaluation techniques and expertise and are, also, time-consuming. But on the other hand, they can provide the needed justification to make the NBS investment.

Despite of the barriers and challenges, UNaLab NBS projects have provided extremely wide NBS knowledge increase among all UNaLab partners and inspired large amount of new replicated NBS actions to be developed and implemented in the partner cities and beyond.

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