3 An integrated approach to green infrastructure

Despite the increasingly recognised benefits of green infrastructure (GI), the consideration and uptake of GI remains limited. The main challenges to mainstream the implementation of GI are related to the institutional, regulatory, and financing framework in place, as well as the existing technical capacity. This chapter identifies and discusses some of these challenges and trade-offs for GI planning and development in OECD countries. It brings together insights, good practices, and a discussion on the lessons learned from the perspective of public governance, environment and transport policies and planning. The chapter considers a life-cycle perspective to propose an integrated approach to GI. It first looks at the institutional and regulatory framework needed to enable GI, to then identify the main elements necessary to promote GI during the planning, appraisal, financing, procurement, and maintenance of infrastructure assets.

Leveraging on lessons learned and international good practices, the OECD has developed an integrated approach to GI which considers the entire life cycle of infrastructure projects and builds on six main pillars. The proposed approach considers all the main trade-offs and challenges involved in GI planning and nature-based solutions (NbS) implementation, and highlights the opportunities to integrate these two instruments in the planning and design, implementation, procurement and delivery, monitoring and maintenance of infrastructure investments.

3.1. Establishing a sound institutional framework for GI

Despite the recognised benefits of GI, governance arrangements are often ill-suited for their planning and implementation. As GI cut across sectoral boundaries, geographical areas, and jurisdictions, GI usually require the **engagement and collaboration of a diverse policy and practitioner community** (Bisello et al., 2019[1]). For example, the creation of green spaces to reduce flooding might require the co-operation of spatial planning agencies and private actors, as well as housing, environment, and water management authorities across levels of government. However, national and local stakeholders tend to work in silos, with limited collaboration and co-ordination across sectoral agencies and levels of government (Nature Squared, 2021[2]).

For this reason, it is **critical to set up an institutional framework that encourages co-ordination**, co-operation, and knowledge exchange across agencies, sectors, and levels of government. In order to enhance co-ordination, it is also critical that the existing regulatory frameworks for GI are harmonised across and within countries. At the same time, a **clear definition of mandates, roles, and responsibilities for the GI planning, implementation, and maintenance** has the potential to accelerate the uptake of GI at all levels of government (OECD, 2020[3]). These key elements to be considered when designing the institutional framework for GI are summarised in the Table 3.1 below.

Table 3.1. Checklist for setting an institutional and regulatory framework for GI

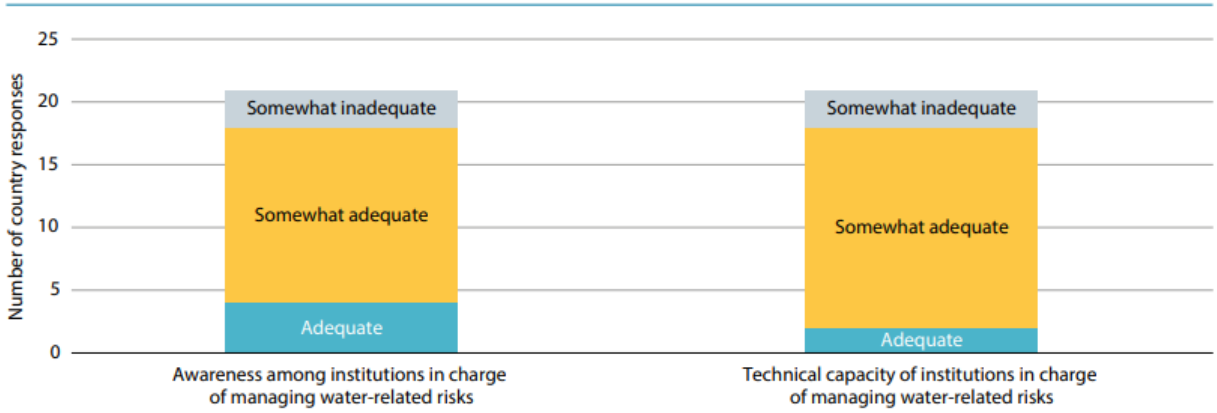
Key institutional arrangements to be evaluated	Key policy elements to be evaluated
Responsibilities for the different phases of GI: planning, implementation, and maintenance	Clear mandate and political support for GI
Co-ordination mechanisms (horizontal and vertical)	Coherence between sectoral policies, and mechanisms to address trade-offs
Partnerships and information sharing	Setting a common narrative and specific guidelines on GI
Integration of GI training in civil engineering and urban planning curricula	Methodologies in place for measuring benefits
Training and education	Inventory of existing natural capital/assets

Source: based on (OECD, 2020[3])

In order to effectively manage GI, the **knowledge base and capacity** of all the stakeholders involved is also critical. Yet, the lack of such capacity is often a key challenge to the planning, implementation, and maintenance of green infrastructures. This was demonstrated by a recent OECD survey, which found that the availability of technical capacity for the design, implementation, and monitoring of green infrastructures as well as the limited awareness of the benefits of ecosystem services and the potential solutions offered by GI within public agencies were major obstacles to GI planning and development (Figure 3.1). The lack of **specific guidance on the planning, implementation, and maintenance of GI** further exacerbates these challenges (Bisello et al., 2019[1]) and makes GI interventions easier to consider in larger cities, which usually have a larger pool of experts and resources to tap into. Consequently, while a growing number of individual GI initiatives exists, these tend to be concentrated in major urban areas, leaving behind smaller urban centres and rural areas. Besides, due to limited capacity, these interventions are often disconnected from other existing GI (Trémolet S. et al., 2019[4]; OECD, 2020[3]), failing to link to

existing ecological networks and to enhance landscape connectivity (Bisello et al., 2019[1]; OECD, 2021[5]). To help raise awareness and build capacity, some OECD countries have started creating toolboxes and guidance books compiling best practices and performance data to support policy makers and GI practitioners in the implementation of GI (OECD, 2021[5]). The United Kingdom compiled over 60 case studies highlighting best practices related to a climate risk: natural flood management. The EU has developed some platforms to support climate adaptation and GI planning, such as ClimateADAPT and Urban Nature Atlas. In order to support decision making phases, the EU-funded UNaLab developed an NbS technical handbook to guide stakeholders in the selection of NbS most adapted to specific contexts (OECD, 2021[6]).

Figure 3.1. Awareness and capacity level for GI across OECD countries



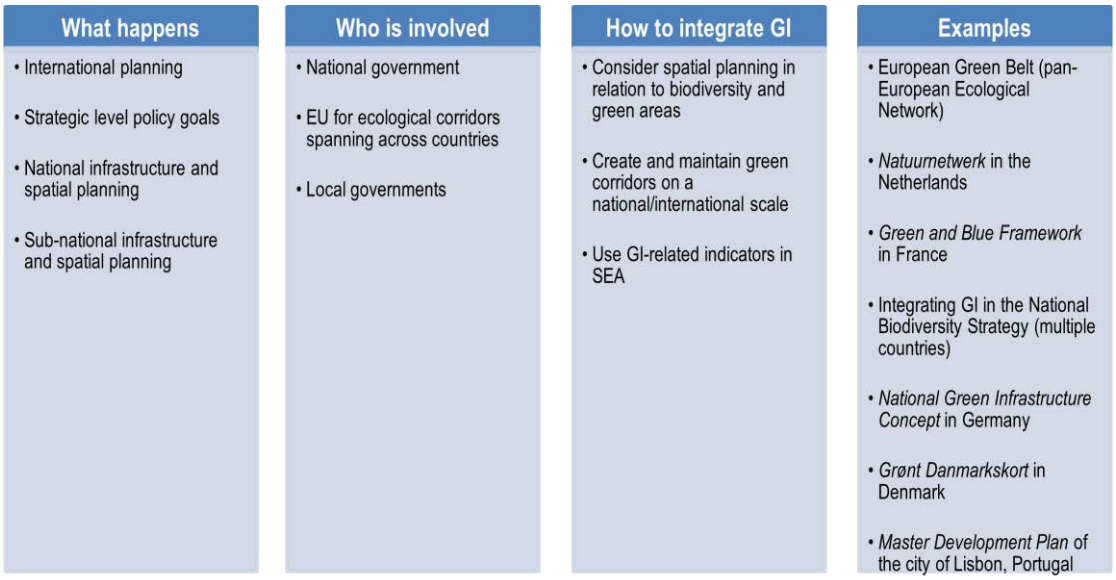
Note: Response to the question: "How adequate are the following features in relation to eco-system-based approaches to water management in your country/basin?"'; multiple responses were possible; no respondents selected "inadequate".
Source: (OECD, 2020[3])

3.2. Planning and developing GI

The planning and implementation of GI largely depends on the policy and regulatory environment of each country and jurisdiction. Indeed, through their plans, strategies, and policies, governments can promote or hamper the development of GI. For example, regulatory and planning instruments at both the national and sub-national level can encourage the consideration of GI in landscape and urban planning processes. For example, strategic environmental assessments (SEA) can recommend or require the integration of GI before individual policies are designed and approved.

The infrastructure planning phase typically involves national governments and sectoral infrastructure agencies. For GI spanning across multiple countries, international bodies, such as the European Union, can also be involved. Sub-national governments are also usually involved, due to their critical role in spatial planning. For example, through their Sustainable Urban Mobility Plan (SUMP), municipalities can promote and plan GI (see Section *Green Infrastructure in Transport Planning in Italy* above). Overall, in order to plan effective green infrastructures, it is critical that spatial planning at all levels of government pays due attention to ecological connectivity across natural areas. In practical terms, this means creating and maintaining green corridors to allow for species mobility and ecosystem services, regardless of national or sub-national boundaries. Figure 3.2 shows a summary of what infrastructure planning encompasses.

Figure 3.2. Overview of infrastructure planning



In some cases, the consideration and planning of GI can be challenging due to the intrinsic characteristics of GI. For example, since GI often requires large spaces to fully deliver its benefits, its consideration in the planning of infrastructure projects might be difficult. This can be particularly problematic in urban areas, where the high demand for land increases the opportunity cost of some types of GI interventions (Nature Squared, 2021[2]; OECD, 2021[6]). Besides, some types of green infrastructures require the active support and participation of citizens and other local stakeholders, such as land and building owners, throughout the planning, implementation, and maintenance process (Frantzeskaki and McPhearson, 2022[7]). This engagement is often gradually built over time through iterative processes that can be perceived as lengthy and costly by local and national administrations (Bisello et al., 2019[1]; OECD, 2021[6]).

Despite these challenges, GI is gaining a growing attention at the international level, and a growing number of good practices and examples of effective GI planning and implementation is being developed. For example, the **pan-European Ecological Network** (PEEN) aims to identify, protect, and ensure the connectivity across core ecosystems and natural areas across several European countries, with the goal of implementing the tenets of the Convention of Biological Diversity throughout the European territory. This pan-European initiative links to many national ones. For instance, in the **Netherlands**, a national network of nature areas and water bodies (the *Natuurnetwerk*) has been developed with the goal of enhancing ecosystem connectivity in the context of the PEEN. The national government and the regions share the responsibility for maintaining and ensuring the connectivity among these areas. The network is included in national spatial planning policies, such as the Structure Vision Infrastructure and Space. Another example of successful planning and development of GI is **France**'s *Green and Blue Framework*, i.e. a national green development strategy that aims to preserve biodiversity, protect the natural landscape, contribute to water management, eventually supporting adaptation to climate change. As for the *Natuurnetwerk* in the Netherlands, the *Green and Blue Framework* needs to be considered in land use and landscape planning throughout the country (Office Français de la Biodiversité, 2022[8]). Several plans and strategies, such as for example the 2030 National Biodiversity Strategy (Gouvernement, 2023[9]), are in place to support the implementation of the Framework at the national, regional, and local level.

Similarly to France, several other **EU countries mention GI in their National Biodiversity Strategies**. These include for example Austria, Belgium, Finland, Germany, Greece, Hungary, Luxembourg, Malta, and Spain. For instance, Austria's National Biodiversity Strategy includes targets on integrating biodiversity and ecosystem services in spatial planning, with a focus on the importance of integrating ecological networks in spatial and landscape planning. In Hungary and Luxembourg, the National Biodiversity

Strategies pay particular attention to the role of GI for climate change adaptation and ecosystem service provision and maintenance. Germany is the only country in the European Union with a *National Green Infrastructure Concept*, i.e. a document that aims at integrating biodiversity and ecosystem services in territorial development policy. The document is also linked to the country's National Biodiversity Strategy.

Denmark's experience with the "*Green Map of Denmark*" (*Grønt Danmarkskort*) is also particularly relevant. The country introduced this tool in its national Spatial Planning Act in 2015, with the aim to ensure that ecologically relevant ecosystems in Denmark were sufficiently interconnected to allow species to move and thrive. Overall, this Green Map sets out a strategic policy framework to ensure that existing and new natural areas throughout the country are located in a strategic way that has the highest impact on ecosystem health and connectivity. The tool also supports land-use planning processes and the planning of new GI by providing a concrete map of existing green areas throughout the country. According to the Danish Spatial Planning Act, municipalities have the responsibility to designate areas to the Green Map based on a common base map and a common set of criteria. Since 2017, Danish municipalities are also required to include GI and relevant natural areas in their municipal plans (Biodiversity Information Systme for Europe, n.d.[10]).

A growing number of good practices in GI planning and implementation is also emerging from sub-national administrations, which are critical to promote GI in spatial planning. For example, the Master Development Plan of the municipal administration of Lisbon (**Portugal**) considers the ecological network as a key element for city planning. The document includes a series of interventions to strengthen the continuity and complementarity of natural and semi-natural systems in the urban territory, which is strongly constrained by the dense urban fabric. Building on this plan, between 2009 and 2017, the local government has developed approximately 190 ha of new green areas as well as six green corridors for better ecosystem connectivity. The resulting benefits include wider accessibility to urban and peri-urban green spaces for residents and tourists, as well as positive impacts on health by promoting active transport modes (walking/cycling), environmental impact gains and additional income (and jobs) from an increased number of visitors (Architects' Council of Europe, n.d.[11]; Biodiversity Information System for Europe, n.d.[12]; OECD, Forthcoming[13]).

3.3. Financing GI

Today, green infrastructures are mostly financed through public budgets and philanthropic initiatives (Ozment, Ellison and Jongman, n.d.[14]). According to the UNEP, current global investments for green infrastructure are around USD 133 billion[1] every year[2] (UNEP, 2021[15]). Of these, USD 115 billion (i.e. approximately 84%) come from public resources, mainly in the form of government spending for the protection and restoration of biodiversity and landscapes and through specific government projects on sustainable forestry, agriculture, and fisheries. In addition, an average USD 18 billion come from private sources, mostly in the form of investments in sustainable supply chains and environmental offsets. While considerable, these channels alone are often insufficient to support the effective implementation of green areas at the landscape level (Ozment, Ellison and Jongman, n.d.[14]). Indeed, to meet existing international policy targets and effectively address the climate crisis, land degradation and biodiversity loss, global investments in ecosystem conservation would need to almost triple by 2030 and to reach at least USD 536 billion per year by 2050[3] – i.e. at least four times the amount invested today. At the global scale, this corresponds to a financing gap of about USD 403 billion per year (UNEP, 2021[15]).

The financing of GI initiatives that promote ecosystem preservation and restoration often meets a number of challenges (Trémolet S. et al., 2019[4]; OECD, 2021[6]). First of all, ecosystems and their services represent a public good whose many co-benefits are usually not traded in the market. For this reason, the economic benefits associated to their conservation, as well as the costs associated to their degradation or loss, are often not adequately valued, or considered, in policy and economic decisions. This challenge is

further exacerbated by the fact that GI provide diffuse benefits and co-benefits on a large geographic scale, often leading to a mismatch between the stakeholders who pay for ecosystem and biodiversity conservation and the broader communities that benefit from their preservation (Rendlen and David, 2021[16]), and thus making it difficult to reward those who contribute to the financing of GI (OECD, 2021[6]). Besides, green infrastructures are dynamic systems that provide benefits and returns over long timeframes, which can discourage private investors and administrations that seek for short- or medium-term economic and political returns and service levels (Nature Squared, 2021[2]; OECD, 2021[5]). All these factors combined tend to discourage the consideration and integration of GI initiatives.

Yet, as highlighted by the Nature-based Solutions Global Resource Centre[4], there exist a variety of fiscal interventions, market and regulatory instruments, and other hybrid mechanisms that can be used to finance GI at the government level and to crowd in further GI financing from private stakeholders (Rendlen and David, 2021[16]). When effectively combined, these instruments and interventions can make GI more attractive for potential financiers (OECD, 2021[6]).

- ***Tax Increment Financing*** can be used to finance GI and broader ecosystem regeneration projects based on anticipated future tax revenues resulting from GI development. When a Tax Increment Financing district is established, the "base" amount of property tax revenue is recorded using the status quo before improvements. For example, a new public green space prompts a rise in property values, leading to an increase in actual property tax receipts above the base. While the base amount of property tax revenue continues to fund the maintenance of GI, the additional tax revenue can be used to pay bonds and reimburse investors.
- ***Blended public funds*** providing capital in the forms of grants, equity or debt consist in funds from the budgets of several public entities that are pooled and used to fund or de-risk investments in nature and biodiversity as part of a blended finance scheme. This mechanism provides a source of risk capital that can leverage other sources of financing, with the additional benefit that the funding comes from existing budgets.
- ***Debt-for-nature*** represent an opportunity for raising financing to address biodiversity, ecosystem, and climate challenges. Under these schemes, a creditor government or business swaps repayment against the debtor's commitment to fund local conservation projects. NGOs or donors can also purchase a debt and then swap it against the debtor's commitment to fund specific GI.
- ***Carbon tax*** levied on activities that are harmful to nature can also largely contribute to GI initiatives through the tax revenues, which can be earmarked to fund nature conservation measures.
- ***Betterment levies*** consist in a tax or fee levied on those lands that gain value following a GI intervention. Under this scheme, the stakeholders that benefit from GI, such as land or property owners benefitting from higher revenues or higher property valuations, can be subject to an additional tax whose revenues can be used to maintain the GI that generates this value increase. Betterment levies can also be used to fund non-revenue-generating green infrastructures.
- ***Business improvement districts*** consist in contracts stipulated between municipal governments and private capital holders, under which the latter must contribute towards the rehabilitation of natural areas or ecosystems. Once a given level of regeneration is achieved, the 'district', comprising public and private counterparts can then take responsibility to manage and maintain the GI.
- ***Trading of storm water credits*** are schemes for the trading of credits to manage storm water and the pollution of natural waterways from storm water discharge. The revenues generated through credit sales are then used to establish a secondary market to attract private investment for larger storm water management initiatives. In other words, this mechanism creates a monetary value for stormwater management, which incentivises property developers to explore GI potential to address water management issues.

- ***Resilience bonds*** are bonds issued to finance climate-resilient upgrades that are paid back through subsequent cost savings, which can result from example from lower insurance premiums. In other words, this instrument aims to shift financing from post-disaster relief to pre-disaster preparedness and prevention. By transferring disaster risk from governments to insurers, resilience bonds allow to raise financing for GI that could otherwise not be realised. This instrument is, however, still in the pilot stage.
- ***Payment for ecosystem services (PES)*** are instruments that incentivise and compensate stakeholders for developing or maintaining GI. Under PES schemes, beneficiaries are encouraged undertake restoration and conservation actions that benefit them as well as the broader community. PES can be used as revenue streams from GI and ecosystems that would otherwise not generate any income.
- ***User fees*** are fees levies on the users of natural capital in exchange of the ecosystem services they benefit from. This could encompass, for example, entrance fees paid by those who visit national parks.
- ***Transfer arrangements*** are schemes that involve the transfer of natural assets to community organisations at less than market value, requiring in exchange the management, conservation, or regeneration of those lands and ecosystems.

3.4. Promoting the use of nature-based solutions in project planning, prioritisation and appraisal

Project design, prioritisation and appraisal offer an excellent opportunity to assess and promote the benefits of Nature-based Solutions. In this project phase, further project-level planning, evaluation, and design take place, e.g. planning a specific link or segment of a transport network. Moreover, the inclusion of GI and NbS considerations from the project preparation phase would also facilitate the access to climate-based and blended financing.

Integrating NbS in project design would also require engaging all relevant stakeholders, including citizens and local communities, since the beginning of the project. The early engagement of local communities would contribute to create a sense of ownership and responsibility with respect to the infrastructure projects under scrutiny, and it will also help them better understand all the challenges and trade-offs that need to be considered when integrating NbS. Despite some additional costs and efforts in the design and evaluation phase, the early engagement of local stakeholders will pay back at the implementation and maintenance, avoiding delays, additional costs and inefficiencies.

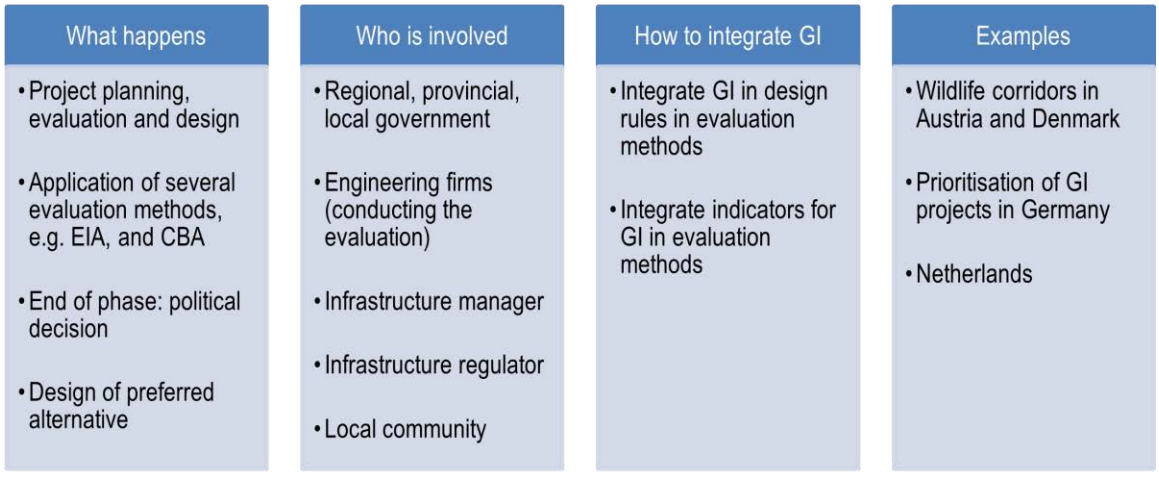
The project evaluation uses many assessment procedures and methods, the most common ones being EIA and CBA, as are also applied in Italy. This phase ends with the political decision for a specific project option. There are usually multiple stakeholders involved in this phase, depending on the nature of the project. Stakeholders come from the public (e.g. relevant governments, regulators) and private sector (e.g. engineering companies, firms conducting the evaluations, and infrastructure managers). Moreover, public consultation is typically part of this phase. An overview of the elements of project planning, prioritisation and appraisal is outlined in Figure 3.3.

In addition to their primary purpose, NbS can generate ancillary social, economic and environmental co-benefits related to human health and livelihoods, food and energy security, ecosystem rehabilitation and maintenance, climate adaptation and resilience, and biodiversity (Browder et al., 2019[17]). While the benefits of traditional grey infrastructures are immediately visible, green infrastructures and infrastructures with NbS generally take a longer timeframe to fully materialise their benefits (Kabisch et al., 2016[18]; OECD, 2020[3]). These co-benefits of both GI and NbS are often not reflected in traditional assessments carried out at the appraisal stage of infrastructure decisions and investments. The existing methods for

assessing, valuing, and monitoring these co-benefits are often underdeveloped or challenging to apply (Trémolet S. et al., 2019[4]). Moreover, there exist a wide variation in the type of ecosystem services NbS support, and the specific costs and benefits of different infrastructure solutions are dependent on local circumstances (Brown and Mijic, 2019[19]) . Finally, there can be trade-offs between different ecosystem services. For example, enhancing the recreational capacity of a park may lead to pressures on its biodiversity through more intense use and associated disturbances.

Nonetheless, there are ways to encourage the consideration of NbS versus traditional grey solutions, using a combination of traditional appraisal tools and non-traditional methods that allow for more inclusive reporting on indicators that grasp the benefits of NbS. This can even be applied within the existing procedure of EIA. In addition, this can also be integrated into the CBA methodology for the assessment and comparison of project alternatives but complementing them with, for example, multi-criteria analysis (MCA), which allows for comparing project alternatives on their scores on both quantitative and qualitative criteria. It, therefore, allows for a fairer comparison with projects that do not necessarily score high on monetary outcomes but do have benefits to nature and social indicators.

Figure 3.3. Overview of project prioritisation and appraisal phase



One example where NbS are integrated in **project planning** is the “Infranature” programme in the Netherlands. This programme is a so-called “Green Deal", which is an agreement between the State and other stakeholders, where the State commits to update legislation and regulation, act as a mediator or develop new markets. Green Deals are thus focused on co-operation and are not a financing instrument. The Infranature programme supports infrastructure that integrates and supports biodiversity. Up until today, twenty-three infrastructure stakeholders have joined the initiative and have thus promised to ensure an increase in the attention to biodiversity in the construction, management and maintenance of infrastructure (i.e. highways, railways, waterways)[5]. Examples of projects within the programme are sound walls with integrated greenery next to a highway or insect-friendly maintenance of roadsides (InfraNatur, 2019[20]).

Another option for the promotion of NbS in project planning is by defining specific rules for biodiversity conservation for certain types of projects. In Austria, this type of rule is applied in the planning of roads and railways[6]. If these infrastructures cross nature areas and create a barrier for wildlife, it is mandatory to establish a wildlife corridor, such as an eco-bridge or tunnel every three kilometres at a minimum. The width of the wildlife crossing must be at least 25 to 80 metres, depending on the situation. This inclusion must already be present in the project design, and it is assessed in the EIA procedure. Newly built roads and railways must comply with these conditions, and existing infrastructures are also being updated to comply with the rules[7]. Denmark has a similar mechanism to ensure safe wildlife crossings; the risk of

fragmentation of habitats and ecosystem is assessed in the EIA and corrective solutions are then integrated in projects' design and implementation.

There are also multiple solutions to promote the use of NbS in the prioritisation and appraisal of infrastructure projects. Countries can integrate NbS in the appraisal process by assessing and factoring in the impacts of infrastructure projects on biodiversity. Most notably, in 2009, The Netherlands developed the biodiversity points method, which measures the amount and quality of ecosystem services and biodiversity and their changes (i.e. the project's impact) in a standardised way. Its use is recommended in the national guidance on CBA. The biodiversity points are calculated by multiplying three components: (i) the area of natural and semi-natural ecosystems affected (in hectares or square km); (ii) the ecological quality of each area; (iii) a weight factor per type of ecosystem, which reflect the contribution of the ecosystem to the species richness at the national, European or global level. The weight factor varies according to the species population the ecosystem and their threat level (Bos and Ruijs, February 2019[21]).

Another way to promote the integration of NbS in the prioritisation and appraisal of infrastructure projects is by developing indicators, and eventually targets specific for NbS. For each project, it should be made clear how it contributes or affect such indicators or targets. For example, the European Environment Agency (EEA) proposes indicators to measure and consider the share of green areas in cities or the distribution of green urban areas for urban infrastructure projects[8]. Non-urban indicators can be related to biodiversity, fragmentation, and buffer zones. Another example related to the use of indicators and targets is the Interreg Danube Programme, which has developed a training package on using EIA for integrated GI planning[9]. According to this training package, a multi-criteria analysis (MCA) should be used to differentiate between project alternatives. The criteria to include should be measurable and preferably economically representative. They should consist of habitat loss, habitat fragmentation/permeability and disturbance, and criteria related to the individual projects, such as their influence on critical habitats. Moreover, the selected option is bound to three constraints: 1) the lowest degree of habitat loss; 2) avoiding intersections of natural protected areas; 3) avoiding intersections of ecological corridors.

3.5. Procurement and delivery of NbS

In order to promote the implementation of nature-based solutions, public administrations can leverage their purchasing power. As of today, public procurement accounts for 12% of GDP across OECD countries, testifying that the public sector's demand cover a relatively large market share. In addition to that, public authorities can lead by example, encouraging other administrations, businesses and citizens to invest in and implement NbS.

To date, public procurement of NbS is still limited. This is probably due to the relatively novelty of NbS concepts in mainstream planning practices, which implies public administrations might not yet be familiar with the purchase of these particular "products/services". Moreover, there are other challenges public procurers are likely to face, and these are summarised in a recent report published by the European Commission (2020[22]).

As mentioned in the previous section, there is no widespread consensus on the most effective tools and methodologies to measure and quantify natural assets' performance, including associated costs and benefits. Likewise, the strong diversity of needs and technologies for NbS implementation makes it challenging to develop a systemic classification. This feeds public procurer's uncertainty about what specific work/service/product to purchase and the results it can achieve.

Public buyers also have difficulties in finding contractors with the adequate experience and skills to deliver NbS. In addition to that, public tenders for NbS tend to have low contract values. The combination of a low contract value with high technical requirements struggle to attract significant interest from the market. This

results in low numbers of bid submitted and reduced competition, which has negative affects the quality of the offer.

In addition to economic and environmental impacts, NbS offer social benefits, such as enhanced quality of life, increased access to public green spaces, new opportunities for social interaction among community members, recreational, cultural and educational value, enhanced physical and mental well-being of people, and so on. In many cases, the involvement of the local community is key to ensure NbS are designed and procured effectively to meet the needs of the area, as well as to ensure their adequate maintenance over time. However, many communities have had negative experiences in engaging with public authorities, and there is an impression that the local community's views and needs are often ignored and not acted upon. This has often resulted in a lack of trust towards public authorities, which leads to consultation fatigue and little to no engagement by citizens in NbS.

Finally, and as public procurers use taxpayers' money, they tend to adopt a risk-adverse approach and prefer predictable and familiar processes and solutions. This results in the procurement of conventional "grey" solutions. In other words, the limited track record of NbS so far, and the "high-risks" and "high-costs" that are traditionally associated to green solutions feed the reputational concerns of public buyers.

The report by the European Commission also identifies some key tools and strategies for governments and public buyers to facilitate the procurement of NbS. These include (Mačiulytė and Durieux, 2020[23]):

- **Development of Key Performance Indicators (KPIs)**. KPIs to measure and quantify the environmental, social and economic performance of NbS would help practitioners to grasp the holistic value of solutions based on natural assets.
- **"Brokers of NbS"**. Public administrations need to identify innovation brokers, specialised in nature-based projects and solutions. These brokers can promote the procurement of NbS by advocating their value, promoting knowledge transfer and dissemination, helping to break barriers to procurement of such solutions in specific contracting authorities and/or public administrations.
- **Create centres of excellence on procurement of NbS**. Establishing national, regional, or local centres of excellence for procurement of NbS to gather and disseminate best practice examples, develop guidelines and handbooks for implementation, provide training and capacity building, offer ad-hoc technical assistance, and so on.
- **Provide policy support to procurement of NbS.** By developing and adopting a set of policies and a regulatory framework that explicitly support public procurement of nature-based solutions, the government strengthen the incentives for public buyers to incorporate them in their purchases. Considering the difficulties faced to demonstrate the financial case for procurement of NbS, policy support from the top government or higher administrations is pivotal.
- **Promote cross-departmental exchange**. Procurement of NbS needs interdisciplinary skills and knowledge (i.e. law, ecology, economy, natural sciences, engineering, etc.). For this reason, it is important to overcome the silos modus operandi that characterizes the public administration and encourage the interaction of the actors relevant for the successful implementation of NbS. This can be done with the creation of multidisciplinary teams, the establishment of cross-departmental units, or organizing exchange occasions, such as workshops and informal events.
- **Adopt challenges-based thinking in calls for tenders**. Given the wide range of needs NbS can address and the many technical solutions available for their implementation, public procurers often find it difficult to draft clear technical specifications. The suggestion is to focus more on specifying the desired outcomes and let suppliers free to develop innovative solutions to achieve them. Such objectives can be specified in the award criteria. Moreover, taking into account the novelty and complexity of NbS, public administrations should opt for innovative procurement procedures (e.g. the innovation partnership, competitive dialogue, and competitive procedure with negotiation) which allow to have a dialogue with private businesses to develop an effective and high-quality solution. Even though up-front costs might increase for public administrations, in the long-run, NbS

are likely to save money. Preliminary market consultation is also key to gauge market capacity to design and provide products and services that build on natural elements, as well as to develop effective public tenders.

- **Joint procurement**. As public procurers face difficulties in finding suppliers due to low contract value, a solution could be to group together several small contracts for NbS in a single call for tender or establish framework agreement with a pool of suppliers. Also, joint procurement among different contracting authorities can increase the tender value and provide a higher incentive for suppliers to participate.
- **Joint NbS network**. As of currently, different public administrations are implementing projects that leverage natural assets and green solutions. Joining platforms where peers meet, and exchange ideas and lessons learned can help public buyers to overcome the procurement challenges they face.
- **Engage the community**. Considering the high potential of NbS to deliver social outcomes and the key role local communities can have for their effective implementation and maintenance, public administrations need to engage with them. Pilot projects that can showcase the benefits of NbS and give proof that the people's feedback is valued and acted upon can help gain their trust and increase the community's willingness to engage in the design, implementation and maintenance of nature-based products, goods, and services.

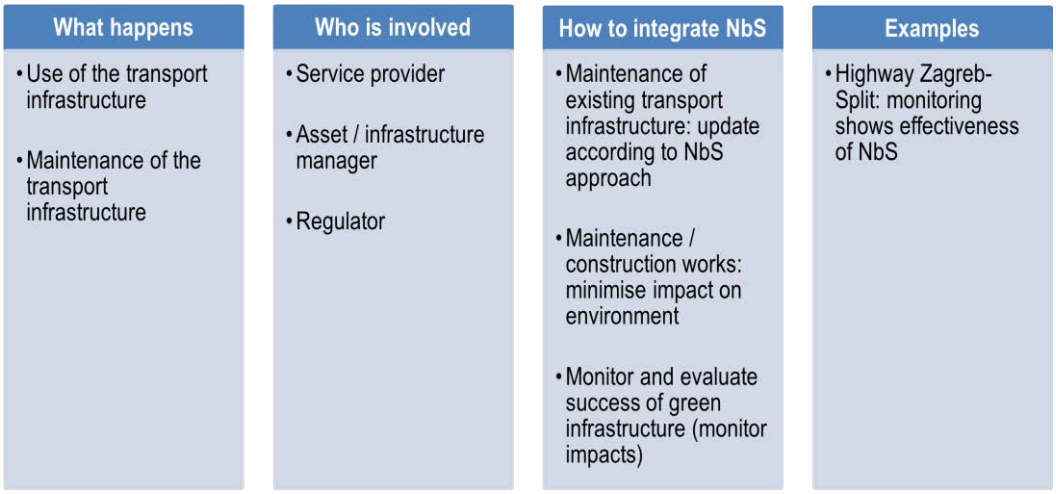
Even though public procurement is an important instrument public administrations can leverage to promote NbS, publicly-led initiatives need to be complemented with alternative delivery mechanisms. Successful public procurement of nature-based solutions in infrastructure projects is useful to create visibility and interest in the topic, but other tools that can increase an incentive also for other social and economic actors to act are necessary. These will help to effectively achieve a widespread implementation of NbS in public investment projects, therefore delivering their full potentials and benefits (European Commission, 2020[22]).

3.6. Monitoring and integrating NbS across the infrastructure lifecycle

Monitoring and maintenance of infrastructures are key to safeguard the function they had planned to fulfil. These actions should be performed throughout their entire lifecycle and include both use and upkeep. This is even more important for infrastructure projects that build on natural assets and integrate nature-based solutions. Natural components and natural processes are complex and dynamic, and they are also more sensitive to a wide range of factors, including changing climate conditions, the surrounding environment, quantity of users, frequency, and modality of use, etc. For this reason, it is necessary to constantly monitor infrastructure projects that include NbS to assess their status and level of performance and intervene as needed.

Regarding monitoring, performance indicators should encompass both the use and maintenance phase of infrastructure projects. Particular attention should be paid to assess the performance on biodiversity and ecosystem services criteria to assess the effectiveness of NbS in delivering the expected objectives. Results from monitoring should then be used to inform the management of the infrastructure, including changes in the modalities of use and effective maintenance. Government is usually less involved in this phase, and responsibilities are delegated to service providers and infrastructure managers. However, a regulator is typically involved in reviewing their performance and monitoring the infrastructure's functionality. Some infrastructure projects and programmes even have their own monitoring committee. An overview of this phase is outlined in Figure 3.4.

Figure 3.4. Overview of infrastructure monitoring and maintenance



Monitoring and maintenance help ensure infrastructure projects stay in good shape after realisation, ensuring they fully deliver the expected results. It is important to start monitoring early. For example, start at least in the appraisal phase by setting out indicators for monitoring the infrastructure during its lifetime. The monitoring and maintenance phase can also be adapted for existing infrastructure assets to keep track and improve their impacts on ecological connectivity by integrating NbS.

An example of monitoring the effectiveness of NbS in infrastructure projects is the highway between Zagreb and Split in Croatia. This highway was built with multiple tunnels, green bridges, and underpasses for wildlife. One of the objectives was to reduce habitat fragmentation and enable wildlife to cross the highway into other natural areas. Monitoring has since shown that wild animals do use these different facilities. However, green bridges are more effective than underpasses, especially for larger wild animals[10].

Monitoring can also be used to intervene on existing infrastructure assets and networks, and integrate NbS to improve their performance, extend their lifespan, and make them more resilient to changing climate conditions and extreme weather events. The Alps-Carpathians corridor is an EDRF-funded initiative[11] to restore biodiversity and wildlife in the Alps-Carpathians region around the border of Austria and Slovakia. The region, historically a migration route for wildlife, was fragmented as a result of economic development, and transport infrastructure broke up habitats. Several roads have since been upgraded to include green bridges for wildlife passage.

Regarding maintenance, this is key to ensure continuity of service and the high-quality performance of every type of infrastructure, especially NbS. The maintenance of NbS may require the active support of local communities and citizens, for example through tasks such as replanting trees or maintaining water retention structure. For this reason, engagement of key stakeholders should be undertaken from the very early stages of infrastructure investments, for example in the design phase. This will help feeding a sense of ownership and responsibility, therefore ensuring stakeholders' active participation in maintenance activities. In 2019, the city of Turin decided to procure green walls for two public buildings, and maintenance required the participation of the local community. The community engagement started at the very beginning with local inhabitants selecting the two buildings for the project. The city considered several schools and public buildings and engaged with their occupants. The purpose was to find occupants who were truly interested in the project, would benefit from it, and were motivated to take part in maintenance duties in the long run. The selected buildings were a public school where teachers, where keen on using green walls and maintenance activities as an educational tool for students, and a homeless shelter, where maintenance of green walls could provide residents with contact to nature and opportunities to learn new skills. Thanks to the community engagement in maintenance activities, the city of Turin also saved money (European Commission, 2020[22]).

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Notes

[1] Estimates are taken from the report "State of Finance for Nature Tripling investments in GI solutions by 2030", published by UNEP in 2021. As specified in the original text, these estimates are uncertain because capital flows into GI are not tracked or reported consistently. The methodology – which is described in the Annex to the report - employs data sets on public and private expenditure relevant to GI. However, none of the existing data sets label GI transactions explicitly. Moreover, only a small subset covers the universe of relevant transactions that are internationally comparable. Hence, the methodology relies upon assumptions to separate out the GI component of capital expenditure. The quality of the data varies widely across sectors and geographies, so the uncertainty of estimates varies to reflect this (UNEP, 2021[15]).

[2] The report of reference uses the global standard developed by the International Union for the Conservation of Nature (IUCN) for green infrastructures. Accordingly, GI is defined as "*actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits*". The following preliminary principles are to be considered with this GI definition: (i) GI embrace nature conservation norms (and principles); (ii) GI can be implemented alone or in an integrated manner with other solutions to societal challenges (such as technological and engineering solutions); (iii) GI are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge; (iv) GI maintain biological and cultural diversity and the ability of ecosystems to evolve over time; (v) GI are applied at a landscape scale; (vi) GI recognize and address the trade-offs between the production of a few immediate economic benefits for development and future options for the production of the full range of ecosystem services (UNEP, 2021[15]).

[3] These estimates are based on an immediate action scenario, in which the global community is assumed to act now to halt climate change at 2 degrees; reverse loss and stabilize biodiversity intactness by 2050 at today's levels; and stop land degradation. Decisive action begins in 2020 in this scenario. Immediate Action Scenario has been developed by Vivid Economics for the UK's Treasury Under the Dasgupta Review. It depicts a future in which the world acts immediately to combat climate change and halt biodiversity depletion. The Annex to the UNEP Report provides a full description of the underlying assumptions (UNEP, 2021[15]).

[4] The Nature-based Solutions Global Resource Centre is an initiative led by the International Institute for Sustainable Development (IISD) and supported by the Global Environment Framework and MAVA Foundation.

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