Promoting Nature-based Solutions in Municipalities in Hungary

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Abbreviations and acronyms

BNSF	Burlington Northern and Santa Fe Railway Company
BREAM	Building Research Establishment Environmental Assessment Method
CAP	Common Agricultural Policy
CFE	OECD Centre for Entrepreneurship, SMEs, Regions and Cities
DG	Directorate-General
EFAB	Environmental Financial Advisory Board
ENV	OECD Environment Directorate
EPA	Environmental Protection Agency
EU	European Union
FIDIC	International Federation of Consulting Engineers
GDP	Gross domestic product
GI	Green infrastructure
GSF	Green space factor
IEEP	Institute for European Environmental Policy
IISD	International Institute for Sustainable Development
IPCC	International Panel on Climate Change
ITS	Integrated Urban Development Strategy
IUCN	International Union for Conservation of Nature
KEHOP	Environmental and Energy Efficiency Operative Programme (Környezeti és Energiahatékonysági Operatív Program)
KÖFOP	Public Administration and Civil Service Development Operative Programme (Közigazgatás– és Közszolgáltatás-Fejlesztési Operatív Program)
KOINNO	Competence Centre for Innovative Procurement
LGA	Local Government Act
LIFE-MICACC	LIFE - Municipalities as Integrators and Coordinators in Adaptation to Climate Change
LVC	Land value capture
MÉTA	Hungary's Habitat-mapping Database
MIT	Ministry for Innovation and Technology in Hungary
MSB	Swedish Civil Contingencies Agency (*Myndigheten för samhällsskydd och beredskap)*
MTI	Ministry of Technology and Industry in Hungary
NbS	Nature-based Solutions
NCCS-2	Second National Climate Change Strategy
NGO	Non-governmental organisation
NKP	National Environment Programme
NWRM	Natural Water Retention Measures
OECD	Organisation for Economic Cooperation and Development
OP	Operative Programme
OTÉK	National Urban Planning and Requirements in Hungary
PES	Payment for ecosystem services
PMO	Prime Minister's Office
PUB	Singapore's National Water Agency
PWD	Philadelphia Water Department
SEV	Société des Eaux de Volvic

SNG	subnational government
SUDS	Sustainable drainage systems
UCLG	United Cities and Local Governments
UN	United Nations
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
VEKOP	Competitive Central Hungary Operative Programme (Versenyképes Közép-Magyarország Operatív Program)
WWAP	World Water Assessment Programme
WWF	World Wide Fund for Nature
ZIFFA	Green Infrastructure Development and Maintenance Action Plan

Executive summary

The ways in which infrastructure is designed, planned, and built will be crucial for determining future vulnerability to climate impacts. Conventional approaches to infrastructure provision rely upon engineered solutions to provide infrastructure services. For example, flood walls, pumps and drainage pipes can be used to manage flood risk. Nature-based solutions (NbS) provide a complement or alternative to conventional approaches by maintaining, enhancing and restoring ecosystems. For example, wetlands can be used to reduce downstream flood risk by regulating water flow. NbS encompass a broad range of interventions, from green roofs and urban parks in cities to the protection of watersheds, forests and degraded land.

The use of NbS can be more cost-effective and create additional co-benefits compared to relying solely upon conventional infrastructure. Overall capital costs are generally lower for NbS than for conventional infrastructure, although maintenance costs can be higher. Beyond this, NbS can provide additional co-benefits compared to conventional infrastructure, including reduced greenhouse gas emissions, facilitating climate adaptation, amenity benefits and supporting biodiversity. The benefits that municipalities could gain from NbS are context specific, depending on factors including the type of the addressed risk, the scale of the solution, the size of the settlement and population density.

This paper uses the OECD's framework to identify reforms that could help Hungarian municipalities to realise the potential for NbS. It illustrates some of the key challenges in the local implementation of NbS in Hungary and provides international examples of how they are tackled in diverse contexts. It also discusses the role of reforms about the enabling environment to mobilise further public and private investment in climate adaptation.

Status of NbS in Hungary

Climate change is exacerbating existing socio-economic and environmental challenges in Hungary, including flooding and drought, heatwaves and poor air quality. For example, around 90% of ecosystem such as watercourses are in a deteriorated condition, according to the national database of habitats. The high proportion of impermeable surfaces in urban areas contributes to the overload of drainage and sewage systems, resulting in flooding during heavy rainfall events. As the pace and severity of climate change increases, there is an urgent need to address the drivers of environmental risks, including agricultural practices that make unsustainable use of natural resources and urban development.

While there is no clear definition of NbS in Hungary, their uptake has grown over the past 10 years, with more than a hundred projects currently underway. Subnational governments in Hungary increasingly recognise NbS as a valuable tool to address multiple policy goals, particularly in relation to urban development and water management. For example, in Budapest, NbS are being mainstreamed in urban planning documents such as the Budapest 2030 Long-Term Urban Development Concept, the Smart Budapest City Vision and the Green Infrastructure Action Plan.

According to a national survey, 70% of local governments used the concept of green-blue infrastructure or NbS in their work. However, interventions tend to be small-scale and the use of grey infrastructure

remains the default approach to service provision. Projects are generally inconsistent with the strategic objectives of policy frameworks. For example, whereas the objective of water retention is reflected in several strategic documents, projects usually tend to be prioritised based on their ability to drain greywater and wastewater. In addition, the OECD survey undertaken for this report has highlighted the following challenges to scaling up the use of NbS:

- Co-ordination challenges: implementing NbS often requires action across administrative and policy boundaries due to their multi-faceted nature, but current arrangements remain fragmented. For example, the different elements of water management -- water supply, water resources management and wastewater management -- are addressed separately in Hungary both at national and local levels.
- Lack of capacity: Hungary has the fourth-highest level of municipal fragmentation among OECD unitary countries. The average size of municipalities is small, with an average population of just over 3000 inhabitants, which is often associated with a lack of the specialised expertise required to implement NbS.
- Limited financial resources: NbS often have lower upfront costs but higher maintenance requirements than grey infrastructure. EU funding covers upfront costs but not maintenance costs, which favours grey infrastructure even though NbS may have lower lifetime costs, especially considering that municipalities in Hungary have limited financial resources. The share of Hungarian subnational government expenditure in total government expenditure (12.5% in 2020) is significantly below the OECD average (36.6%).

Key recommendations

Develop a common statutory definition of NbS. This would help consistently include NbS in relevant policies and strategies**.** The definition could be based on existing global and EU definitions on NbS and green infrastructure, and would include detailed construction, operation and maintenance guidelines to ensure that the benefits of NbS have been achieved. It could be adopted in the current Environment Act and used in national and subnational policy frameworks and sectoral legislations.

Mainstream NbS throughout relevant national strategies. While NbS are reflected in several national strategies – such as those for water management and agriculture, there remains scope for more comprehensive integration of NbS into many other relevant documents, such as those in relation to forestry, and transport.

Conduct regulatory reforms to address the current lack of systematic consideration of NbS and incentivise the implementation of NbS across all government levels. Sector-specific regulations and technical standards could help scale up NbS in different sectors and across different locations. Key actions could be to:

- **Adjust project selection and public procurement rules to better capture the indirect benefits of NbS**. This could be done by increasing the weighting of environmental criteria in public procurement and grant decisions related to EU and national funding. Integrate the value of biodiversity and ecosystem services into cost-benefit analysis. Ensure that proposals are assessed against costs and benefits over their lifecycle.
- **Strengthen spatial planning and development frameworks at county and municipal level to have an integrated land, soil and water management strategy that fosters NbS, in particular water retention in soils.** The strategy could be embedded in urban green infrastructure planning, such as through the Green Infrastructure Development and Maintenance Action Plan (ZIFFA) or an ecosystem service-based Green Infrastructure Development Plan. It could also be included in the National Development and Territorial Development Concept and the National Urban Planning

and Building Requirements, which could guide local development and urban green infrastructure planning.

- **Revise regulations to favour NbS through the preservation of green areas during the construction of new buildings**. The current regulatory framework could be reviewed to include a mandatory minimum green area alongside an optional maximum building area. Municipalities could adjust their building codes and zoning plans to encourage water retention rather than emphasising drainage, while considering the Water Damage Mitigation Plan.

Create a national Competence Centre for NbS to support capacity development at the municipal level. Based on the model of similar organisations used in other OECD countries such as Germany, the Competence Centre would provide a platform to connect municipalities and key stakeholders, share innovative projects and good practices and provide know-how guides to municipalities. The platform could also combine relevant datasets to support NbS implementation, operation, maintenance and monitoring.

Develop new funding models for the creation and maintenance of NbS and associated infrastructure. EU Structural and Investment Funds provide a vital resource for the installation of new infrastructure, but do not cover ongoing operations and maintenance. Potential additional funding sources could be leveraged by:

- Using land-value capture mechanisms to access some of the increment in land values resulting from development. This could be undertaken as a land value tax, or indirectly through requirements placed on developers.
- Taxing negative environmental externalities, for example by implementing a stormwater fee based on impermeable areas for non-residential zones.
- Expanding the use of payments for ecosystem services (PES), such as carbon credits, to capture the social benefits of implementing NbS.
- Developing a stronger culture of maintenance and secure funding streams for maintenance during the planning phase to supplement revenues from local taxes and charges. In addition, NbS linked to service provision could be financed through tariffs and charges.

1 Potential uses for NbS in Hungary

1.1. Challenges with water management

Hungary faces a range of environmental pressures that are being aggravated by climate change. These pressures include biodiversity loss, exacerbation of floods and droughts, air and water pollution, soil degradation and the spread of invasive species (Ministry of Technology and Industry, 2018[1]).

Water management is a significant challenge in Hungary. Around 22% of Hungary's land area lies in potential flood zones, which is one of the highest ratios in Europe (Szlávik, 2018a). Waterlogging causes regular long-term flooding in Hungary's lowlands: around 45% of Hungary's land is at risk of waterlogging (Csüllög et al., 2014; Szlávik, 2018b)[2]. Hilly areas are affected by flash floods that results in erosion of the upper section of watersheds and strong sedimentation in valleys (Balatonyi, 2015). Flooding leads to water pollution and it is exacerbated by poor land management. Impervious surfaces produce high runoff, overloading combined sewage systems (sewage and rainwater) and temporarily flooding urban spaces (Klein, 1982[2]) (Göbel, Dierkes and Coldewey, 2007[3]).

Droughts are also becoming an increasingly serious issue. Currently, 34% of the land area in Hungary is affected by drought (Szlávik, 2018a). Although Hungary's average annual precipitation has shown only a small change in the past century (Lakatos et al., 2021[4]), three factors have led to a significant reduction of groundwater recharge: an increase frequency of extreme rain events that exceed the ability of soil to absorb water, higher evaporation loss due to higher temperatures; and changing rain distribution during the year, especially drier summers. Droughts decrease the water retention capacity of soil, leading to erosion, soil degradation, and reduced soil fertility (Szlávik, 2018a). Several regions (primarily located in the Northeast) suffer from both drought and flood events (Csizmadia et al., 2022[5]).

The risk of drought has been exacerbated by poor water resource management practices, including inefficient water use and over-abstraction. Irrigation demand for intensive agricultural practices is growing, while drainage channels are built to drain inland water, limiting rainwater retention in those soils. This practice had already caused severe groundwater depletion between the Danube and the Tisza rivers in the 1980s (Pálfai, 1994) and is an issue on every plain (Csizmadia et al., 2022[5]). Rainwater harvesting is not widespread due to low water prices for abstraction. In addition, water utilities have on average 22% water losses through leakages in the supply network (Varga, 2020).

Droughts are the costliest water-related issue in Hungary, resulting in annual average damages of EUR 110 million[3]. This compares with average damages from flooding of EUR 40 million per year. Local municipalities' costs to cover the damages caused by floods and waterlogging are on annual average EUR 10 million (Országos Vízügyi Főigazgatóság, 2021[6]).

Agricultural practices have major environmental impacts in Hungary. By 2010, approximately 99% of the country's total watercourses had undergone some form of hydraulic intervention that significantly altered

[2] In long rainy periods, sandy soils having high permeability fill up with water and groundwater emerges above ground.

[3] Average exchange rate March 2022.

the water network and hydrological conditions. According to Hungary's Habitat-mapping Database (MÉTA), more than 90% of ecosystem services are in a deteriorated condition and only 8% of the watercourses have achieved "good status", based on the Water Framework Directive standards (National Biodiversity Strategy, 2015[7]). Since 1999, agricultural areas in lowlands (covering 57% of Hungary's surface area) have seen accelerated biodiversity losses (Nagy et al., 2020).

1.2. Climate change projections in Hungary

Climate change is causing rising temperatures and decreasing rainfall events in summer, as well as more frequent extreme weather events such as droughts and heavy rainfall (Ministry of National Development, 2017[8]). The evolution of extreme events has a specific spatial distribution and a negative effect primarily on the central, southern, and eastern parts of Hungary.

Temperatures in the Middle-European zone, including Hungary, are rising faster than the global average (IPCC, 2022[9]). Since 1908, annual average temperatures have risen by 1.2°C in Hungary, compared to the global average of 0.9°C. This average temperature increase varies by season, with the highest temperature difference being observed during the summer. During the last century, the average number of heatwave days has increased by five days per year (Lakatos et al., 2012[10]).

Climate projections do not show significant change in the total volume of annual precipitation, but the seasonal distribution is likely to change. A higher proportion of annual precipitation will be provided by intense rainfall, while the number of dry days will also increase. A decrease in summer precipitation of 5% compared with the current values can be expected in the coming decades and 20% by the end of the century (Baloghné Gaál, 2021). Consequently, the number of summer drought days (consecutive days with less than 1 mm precipitation) is projected to increase by 3-20 days.

Climate change impact projections for 2100 show regional variation in climate-related risks: the south-eastern region is projected to become more exposed to drought risks while the western section faces a growing risk of flash floods. Annual water infiltration is estimated to decrease by 50 mm, causing average groundwater levels to decrease by up to 5 metres by 2100 (Ministry of Technology and Industry, 2020[11]).

1.2.1. Implications for key sectors

Climate change is projected to negatively affect biodiversity in Hungary due to shifting habitats. This is projected to result in the loss of many species at the regional level and the introduction of new invasive species. Saline, meadow, marsh and cast soils are the most vulnerable areas (Ministry of Technology and Industry, 2018[1]). Warming will influence natural and agricultural vegetation producing a decline in the yield of most crops. Late frosts and other extreme events will more often endanger fruit and vegetable production (Bene et al., 2019). Small agricultural businesses are high vulnerable to poor harvest due to their low level of capital(Li et al., 2017).

Infrastructure will be disrupted by climate change. As illustrated in Table 1.1. , climate change affects service supply and creates major disruption during extreme events. The ways in which infrastructure is designed, planned, and built will be crucial for determining its future vulnerability to climate impacts. In addition, low-quality urban development can exacerbate risks such as heatwaves, flooding and drought, due to the loss of permeable surfaces and reduced natural water retention.

Table 1.1. Selected impacts of climate change on infrastructure in Hungary

	Higher temperatures	Changing rainfall patterns	Storms
Energy	- Changing patterns of energy demand - Reduced capacity for transmission networks	- Uncertainty on the availability of cooling water for generation - Impact on hydro-generation	Supply interruption to provision of infrastructure services, such as power cuts, road closures and disruption of drinking water supplies
Transport	- Melting roads and railway lines - Negative impact on passenger comfort - Smog during hot weather	- Flooding of transport networks - Subsidence of transport assets	
Water supply and sanitation	- Increased demand for water - Decreased water supply - Negative impact on water quality, due to lower volume - Reduced performance of wastewater treatment plants	- Variability of water supply costs - Overloading of sewerage systems	

Source: (Ministry of National Development, 2017[8])

Climate change affects the social and environmental determinants of health such as clean air, safe drinking water, sufficient food, and secure shelter. Climate change will put additional pressure to health system in Hungary, particularly as a result of excess heat. The impacts of extreme heat are already evident: the number of daily deaths is 17% higher on average during heatwaves. Poor air quality is another risk factor (Páldy, Bobvos and Málnási, 2018[12]). Through these growing health risks, climate change also increases healthcare expenditure, adding extra pressure on public budgets by increasing costs (Hutton and Menne, 2014[13]).

1.2.2. Unequal exposure and impacts across people and places

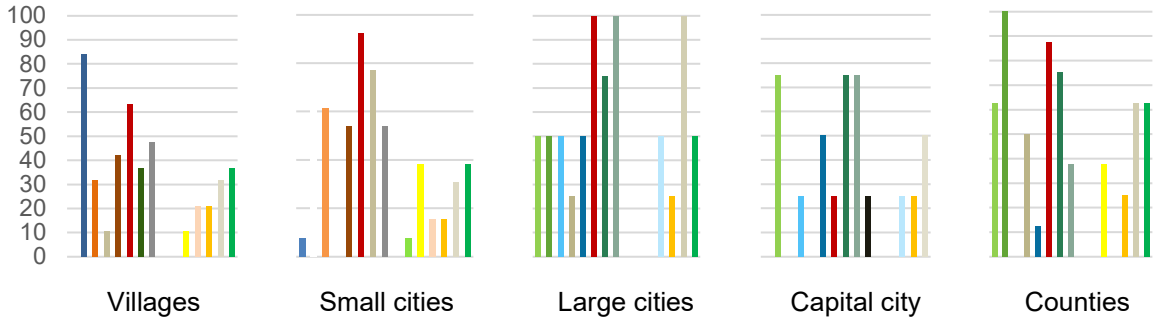
Vulnerability to the impacts of climate change varies across socio-economic circumstances. Low-income families are more likely to be exposed to extreme events because they tend to live in areas that are more exposed to physical climate risks, such as floodplains. In addition, they tend to have less access to quality green areas and mechanical cooling during summer. Age is also an important differentiator: excess mortality during heatwaves tends to disproportionately occur amongst the elderly. Location also has an impact on the severity of impacts. Budapest, for example, has a strong urban heat island effect: a difference of 15°C was measured between the surface temperatures of the Városliget city park and a dense urban housing area (Tatai et al., 2017[14]). The combination of climate and socio-economic changes could increase this by more than seven times towards the end of the century (Bobvos et al., 2017[15]).

Climate change damages vary depending on the settlement type. Damage to conventional engineered ("grey") infrastructure, such as roads or electricity networks, was the most frequent type of problem reported by municipalities, followed by the flooding of buildings (see Figure 1.1.). For 84% of villages[1] (n=16) damage to agricultural land was listed as a major concern, followed by damage to grey infrastructure affecting 50% of them. For small cities,[2] water-related issues are a significant challenge, with a high percentage reporting problems with damage to canals, embankments and erosion. All large cities indicated road and building damages to be major concerns. In Budapest, respondents mentioned flooding and other damage to buildings. At the county level, agricultural damage and damage to infrastructure (e.g., roads, utilities, electricity) and flooding were frequently cited as problems.

[1] Defined as a settlement with a population under 10 000 inhabitants (Csizmadia et al., 2022[5])

[2] Defined as settlements with a population between 10 000 and 50 000 inhabitants (Csizmadia et al., 2022[5])

Figure 1.1. Climate change damages in Hungarian municipalities



● Personal injuries; ● Agricultural crop losses (frost, drought, pests, etc.); ● Damage to canals, embankments; ● Damage to livestock (e.g. due to lack of feed); ● Damage to other grey infrastructure such as utilities; ● Damage to roads; ● Flooding of buildings, basements; ● Restricted use of public spaces (e.g. heatwave, inland water); ● Green area damage; ● Hailstorm; ● Landslides, erosion; ● Obstruction of the operation of institutions; ● forest/vegetation fires; ● Other damage to buildings; ● Power outage

Note: Results based on a sample of 41 respondents from subnational governments in Hungary answering the question "What damage or problems had climate change caused in your municipality?"

Source: (Prime Minister's Office, 2021[16])

1.3. Potential role of NbS in tackling environmental challenges

The main environmental- and climate related challenges in Hungary are related to water security, heat stress, air pollution and loss of biodiversity. Table 1.2 presents the examples of NbS that have been implemented or could be implemented to address these challenges and their associated environmental benefits. For example, wetlands reduce drought impacts by recharging groundwater resources and providing a storage buffer.

NbS can simultaneously address a wide range of environmental, economic, and social challenges, and their implementation can provide co-benefits (OECD, 2020[17]): these can include improving water and air quality, reducing heat island effects and capturing CO_2 emissions. In addition, the use of NbS can yield socio-economic co-benefits linked to health and social cohesion.

The implementation of NbS is mostly driven by objectives related to climate change adaptation and mitigation (e.g., improving environmental and climate risk management, building resilience), sustainable urbanisation and restoration of degraded ecosystem services (European Commission, 2015[18]). National urban policies (NUP) can also play a key role in the promotion of NbS. OECD work on monitoring NUPs shows that, globally, NUPs are recognising "enhanced urban biodiversity and ecosystems" holds strong potential to improve wellbeing, deliver wider ecosystem services and protect cities of all sizes against extreme heat or flooding (OECD, 2021[19]). NbS are effective tools to support these objectives by providing a wide range of other environmental benefits.

Table 1.2. Environmental benefits of NbS

Environmental- and climate-related challenges		Examples of NbS	Potential objectives	Environmental benefits
Water security	Drought	Reforestation, wetlands, rehabilitation of riverbank, etc.	Water collection and reuse, wastewater treatment, groundwater recharge	Increase water availability and quality
	Flooding	Floodplain restoration, implementation of permeable surfaces (parks, green roofs, etc.), restoring upland forests, etc.	Peak flow control, runoff mitigation, erosion control	Flood risk reduction
	Water pollution	Natural and constructed wetlands, riparian buffer strips, floodplain restoration, creek rehabilitation etc.	Soil erosion control, minimize load discharge, capture and removal of pollutants	Improve water quality
Air pollution		Creating parks and open green spaces, green building solutions, etc.	Carbon sequestration, removal of air pollutants	Improve air quality
Heat stress		Protecting/restoring upland forests, creating parks and open green spaces, etc.	Reduce exposure of heat stress, reduce air temperature/cooling effect	Thermal comfort
Loss of biodiversity		Protecting and restoring habitats (e.g., upland forests), creating parks and open green spaces	Improved habitat connectivity, biological control, wildlife, and flora habitats provision	Increase biodiversity, or prevent the loss of biodiversity

Note: The list of examples of NbS is not exhaustive
Source: (Eisenberg and Polcher, 2019[20]; OECD, 2020[17])

The benefits that municipalities could gain from NbS are context specific, depending on factors including the type of the addressed risk, the scale of the solution, the size of the settlement and population density. Settlements with low population density often have high potential for NbS implementation, as there is more land available to implement the necessary measures (Csizmadia et al., 2022[5]).

1.3.1. NbS can contribute to water security

NbS infrastructure can address challenges related to water supply and sanitation, while also protecting ecosystems. The combination of NbS with other measures, such as demand management, can help to regulate the quantity and quality of water. For example, the city of Cape Town, South Africa, recognises that NbS are among the most cost-effective solutions to increase water availability (Box 1.1).

Box 1.1. NbS in the city of Cape Town, South Africa

Starting in 2015, the city of Cape Town experienced its most severe drought period since the last century. The city's water reservoirs reached critically low levels in 2017 and 2018. "Day Zero", the day on which Cape Town switched off its taps, was expected to occur on 16 April 2018. Day Zero was defined as the point at which reservoir levels fell to 13.5%, which would limit residents to a daily allocation of 25 litres per person at public points of distribution. Although Day Zero did not occur, the Cape Town water crisis exposed a serious vulnerability to water scarcity for the city, the surrounding urban agglomerations and the country.

Since the drought, there has been increasing recognition of the value of investing in green infrastructure. The 2019 Water Strategy of Cape Town (2019) relies on a mix of grey and green solutions for its augmentation programme and recognises that NbS are among the most cost-effective solutions to increase water yields. NbS, along with water demand management and improvements in the management of the integrated surface water systems have been prioritised. The Nature Conservancy launched the Greater Cape Town Water Fund to increase collective support by a range of -stakeholders to clear alien invasive vegetation from water catchments to increase water yields. Clearing this vegetation has enabled the creation of several jobs, generating additional positive externalities in Cape Town and its surrounding areas where the unemployment rate reaches 29%.

Source: (OECD, 2021[21])

NbS can help to manage droughts by increasing water storage capacities and slowing the release of water (WWAP, 2018[22]). Such benefits can be unlocked with the implementation of NbS measures such as the restoration and maintenance of water bodies, forest conservation, rehabilitation of riverbanks, floodplain reconnection and restoration, restoration of meadows and pastures, improving soil conservation practices, reforestation of upstream areas, rainwater harvesting, the implementation of sustainable drainage systems, etc. (OECD, 2020[17]; European Commission, n.d.[23]).

NbS can contribute to flood risk reduction

NbS can help to improve water retention, and therefore flood management, by the following measures: (1) interception, (2) increased plant transpiration, (3) improved soil infiltration, and (4) reconnecting the floodplain (Hartmann, Slavíková and McCarthy, 2019[24]). Urban planning can foster intra-urban NbS to mitigate flooding, such as urban forests and terracing on higher elevation levels to delay runoff; green spaces to improve infiltration capacity; renaturation of streams and drainage lines to slow water flows; and the restoration or construction of wetlands in lower urban areas to collect and store water runoff (World Bank, 2021[25]). Land planning at basin level is also key to the successful implementation of NbS, as rainfall itself cannot be altered, but how it runs off land depends on land use and landscape modifications. For example, the use of urban parks and other green spaces in cities for flood alleviation, such as in La Marjal de Alicante (Spain), provides multi-functional amenities (notably recreation and leisure), making them an attractive alternative to conventionally engineered flood defences.

In densely built urban areas, green roofs, green spaces, and permeable surfaces can reduce the risk of flooding by increasing water retention (OECD, 2018[26]). The high proportion of impermeable surfaces in urban areas contributes to the overload of drainage and sewage systems, resulting in flooding during heavy rainfall events. As a result, densely built urban areas are often facing higher flood risks, exposing a large share of the population to climate risks. This has been a significant issue in Budapest, but as Box 1.2 indicates, the expansion of green space helped to reduce the risk of flooding.

Box 1.2. Flood protection in high density areas

In 2020, almost one-fifth of Hungarians (18%) lived in Budapest. The population density of Budapest (almost 3 500 inhabitants per km2) is more than 30 times the national average (112 inhabitants per km2). As such, extreme weather events (e.g., heat waves or floods) in the capital region have the potential to affect a significant and increasing share of the Hungarian population. In addition, the elevated population density, the high share of developed land (70%, compared to 5-7% in other parts of Hungary) and fragmented land ownership in Budapest can make the implementation of larger-scale NbS challenging.

Budapest is better protected from floods than other Hungarian cities on the Danube and Tisa rivers, as the city government has been implementing NbS (e.g., increasing green areas in the city centre and around the Danube as flood buffers) since 2019. For example, Budapest's XVI. district have been facing flooding issues because of the high ratio of impermeable areas in this densely built area. The local government developed a district-level rainwater management strategy that helped to reduce runoff in case of a heavy rainfall event. A catchment-based approach was used to change the districts building codes. New regulations require residential properties to have at least 60% of green area ratio to decrease the runoff from private lands. In addition, swales, permeable surfaces, rain gardens, small reservoirs, and sludge traps were also implemented.

Other Hungarian cities are more frequently and intensely exposed to floods: for instance, Gyor is highly exposed to floods on the Danube, and cities on the Tisa tend to be even more exposed to floods due to the lower levels' protection than on the Danube.

Source : (Csizmadia et al., 2022[5])

NbS can improve water quality

In addition to improving water availability (soil moisture retention, groundwater recharge), NbS can also help to preserve and improve the quality of the available water resources. (OECD, 2020[17]). Natural and constructed wetlands, riparian buffer strips, floodplain restoration and a wide range of other NbS measures can help to improve and protect the quality of available water resources (UN Global Impact, 2018[27]), reducing the treatment costs (WWAP, 2018[22]). Box 1.3 presents natural habitat restoration to improve water quality resources in the UK.

Box 1.3. Nature-based solutions used to improve water quality in the United Kingdom

The United Kingdom's Moors for the Future Partnership targets moorland restoration in the Peak District and South Pennines regions. Industrial pollution and wildfires meant that the moorlands of these areas became one of the most degraded upland landscapes of Europe. One of the objectives of the partnership was to restore these peatlands and create new wetlands. The implemented ecosystem services and nature-based solutions aimed to reduce flood risk, improve water quality, ecosystem restoration, wildfire reduction, and carbon losses.

Moor LIFE 2020 project implemented a range of measures to achieve these objectives. One of the key elements of the project was peatland stabilisation and revegetation to stop erosion. Water erosion washes down the soil from the peat into the nearby reservoirs, reducing their water storage capacity. This region also has high industrial soil pollution. The prevention of soil erosion was key to avoid water reservoirs contamination from heavy metals in the soil, resulting in poor drinking water quality and higher treatment costs.

Sources : (Dean et al., 2014[28]; Crehan, 2022[29])

1.3.2. Reducing environmental challenges related to urbanisation and biodiversity degradation

Human activities such as agricultural practices and urban development can create environmental risks that are exacerbated by climate change. Hungary is facing risks related to heat stress, air pollution and loss of biodiversity. NbS can help to eliminate or reduce such risks simultaneously.

NbS can reduce heat stress

NbS can be an effective tool to mitigate the impact of increasing temperatures and help to reduce the urban heat island effect (Csizmadia et al., 2022[5]; OECD, 2020[17]). The urban heat island effect refers to higher temperatures in urban areas due to their impermeable surfaces, combined with low albedo and evaporation and obstructed wind channels.

Parks, urban forests, green corridors, green walls, green roofs, but also blue infrastructure such as ponds, can be effective tools to reduce temperatures in cities, while also yielding co-benefits for health and wellbeing. Box 1.4 presents a case study from Guelma (Algeria) where nature-based solutions were used to increase the thermal comfort of the city. Plant species can differ in their heat reduction potential; therefore, the cooling benefits of green spaces depend on the species that are planted (Menon and Sharma, 2021[30]). In addition to reducing heat stress in a short term, NbS also promotes compact urban compaction evelopment, because it attracts residents to areas that are surrounded by attractive green and blue spaces (Augusto et al., 2020[31]).

Box 1.4. Reducing urban heat island in Guelma, Algeria

To reduce the urban heat island effect and achieve the optimal thermal outdoor comfort, the city of Guelma has implemented several NbS infrastructure interventions. During the implementation phase, microclimatic data were collected at different points of the examined square, where NbS were installed. The data showed that the expansion of green space and water bodies had a double effect on the thermal comfort of urban spaces: tree canopies help to block the solar radiation and decrease air temperature (-0.8◦C) and increase the relative humidity of the air (+0.7%), while water bodies help to cool down the temperature through the effect of evaporation.

Source: (Sayad et al., 2021[32])

1.3.3. Economic benefits of the use of NbS

NbS tend to have different capital and maintenance requirements compared to grey infrastructure (World Bank, 2021[25]). As a result, depending on the type of intervention and the characteristics of the specific site, NbS can be more cost-effective than traditional grey infrastructure (OECD, 2018[33]; Browder et al., 2019[34]). The use of NbS may incur some additional costs (e.g. capacity building, land costs, labour and equipment for maintenance), but overall capital costs are generally lower than for grey infrastructure (OECD, 2020[17]; World Bank, 2021[25]; Browder et al., 2019[35]) For example, in New York City the combination of green and grey infrastructure for stormwater management reduced the capital costs by 22%, compared to the scenario which only used grey solutions (Browder et al., 2019[35]). NbS can also help to save treatment costs compared to other solutions, for example by saving water treatment costs with reducing the overflow and increasing the quality of the resource (McDonald, R and Shemie, 2014[36]). This may be particularly relevant for Hungarian municipalities that are responsible for providing water supply and wastewater treatment services (OECD, 2018[37]).

NbS also provide additional economic co-benefits. For example, the implementation of NbS can increase the value of surrounding properties and generate additional revenues for the municipality through property taxes or land value capture (Madison, 2013[38]). Furthermore, afforestation, agroforestry, the implementation of green infrastructure, the management of green spaces, and other NbS, can create jobs (Raymond et al., 2017[39]). NbS can also help to make certain sectors, such as farming, fishing, forestry and tourism more productive and sustainable (IEEP, 2021[40]).

NbS can provide a greater economic return on investment compared to other solutions, because of its socio-economic and other co-benefits, which can increase over time (Beigel et al., 2020[41]). As a result, NbS often represent a greater value for money, while they help to address several socio-economic risks that Hungary is facing (Alves et al., 2020[42]).

NbS also provide a wide range of additional social and socio-economic benefits, such as improving physical and mental health by mitigating air and noise pollution and providing space for recreational activities (IEEP, 2021[40]). Beyond the direct benefits, these can result in reduced healthcare costs. These potential health benefits are particularly relevant for Hungary given the ongoing challenges with air pollution.

2 Status of Nature-based Solutions in Hungary

NbS measures are not new in Hungary[4]: traditional land use techniques such as planting of street trees, urban orchards and ditch drains with green strips (*mirhó*) have existed for decades or centuries (Csizmadia et al., 2022[5]). Development pressures from urbanisation and cultural changes led to a decline of these solutions in recent decades, as green spaces were used for development. Grey infrastructure was substituted for traditional approaches, given the perception that it was more effective and required less maintenance. However, NbS have recently been rising again on the agenda of Hungarian municipalities as an alternative or complement to 'grey' infrastructure. This section draws upon the results of a survey undertaken for this project to shed light on the status of NbS in Hungary.

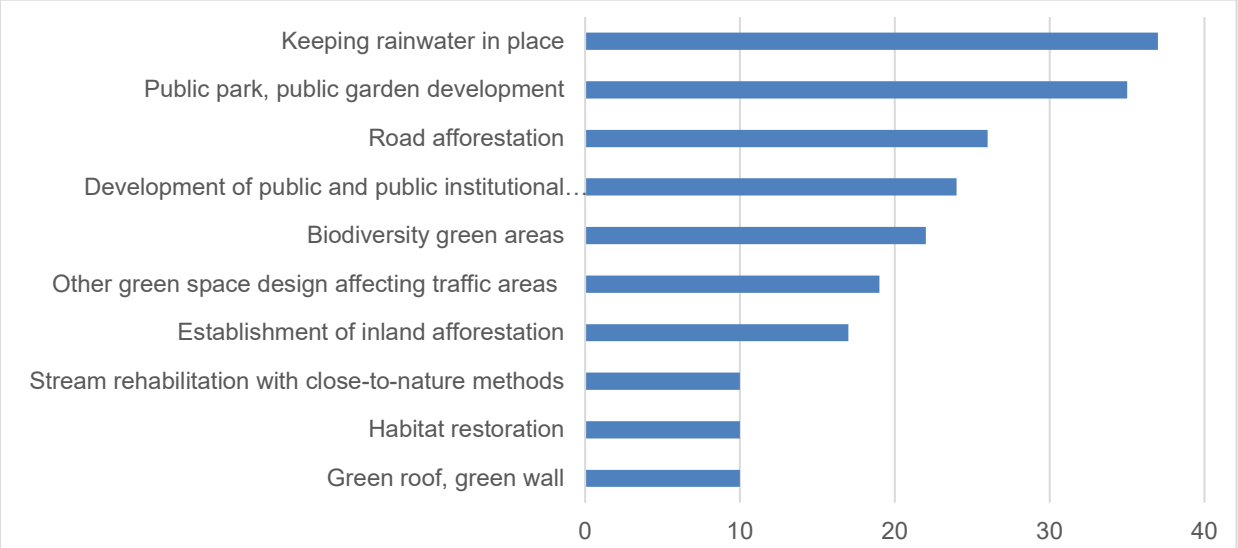
2.1. Growing interest in Nature-based Solutions from Hungarian municipalities

In the previous 10 years, the majority of local governments responding to the survey (70%, n=34) had used the concept of green-blue infrastructure or NbS in their work (Prime Minister's Office, 2021[16]). Landscaping and road afforestation were the most popular measures, followed by the creation of green spaces in traffic areas and water retention.

Most local governments stated that they were planning to develop green-blue infrastructure in the near future, with water retention infrastructure and green spaces being the most common types of intervention. Figure 2.1. provides an overview of all answers. All local government respondents indicated that they would consider water management projects having natural water retention in their municipalities. More than half of respondents had already started the planning process for blue-green infrastructure projects, while less than ten percent have already implemented them.

[4] Numerous traditional Hungarian land-use techniques can be assessed as good NbS practices due to their ability to promote a balanced co-existence of nature and human activities by supporting ecosystems, creating or maintaining high biodiversity and without overly exploiting natural resources. (Csizmadia et al., 2022[5]).

Figure 2.1. Policy goals for green-blue infrastructure considered as important/relevant in the near future[5]



Note: Results based on a sample of 48 respondents from subnational governments in Hungary answering the question "What policy goals do you consider most important/relevant for green infrastructure development in your settlement?"
Source: (Prime Minister's Office, 2021[16]), Survey on Nature-based Solutions in Hungary

In the last ten years, numerous projects have been launched to gather and share knowledge about the related aspects of NbS. Table 2.1. presents some of the most relevant projects, including Hungarian and international case studies. More than a hundred Hungarian NbS projects have been undertaken in Hungary. The listed projects focused mainly on small-scale developments, such as park reconstruction, tree planting or rainwater retention, which is coherent with the survey results (Prime Minister's Office, 2021[16]).

Table 2.1. European projects related to NbS

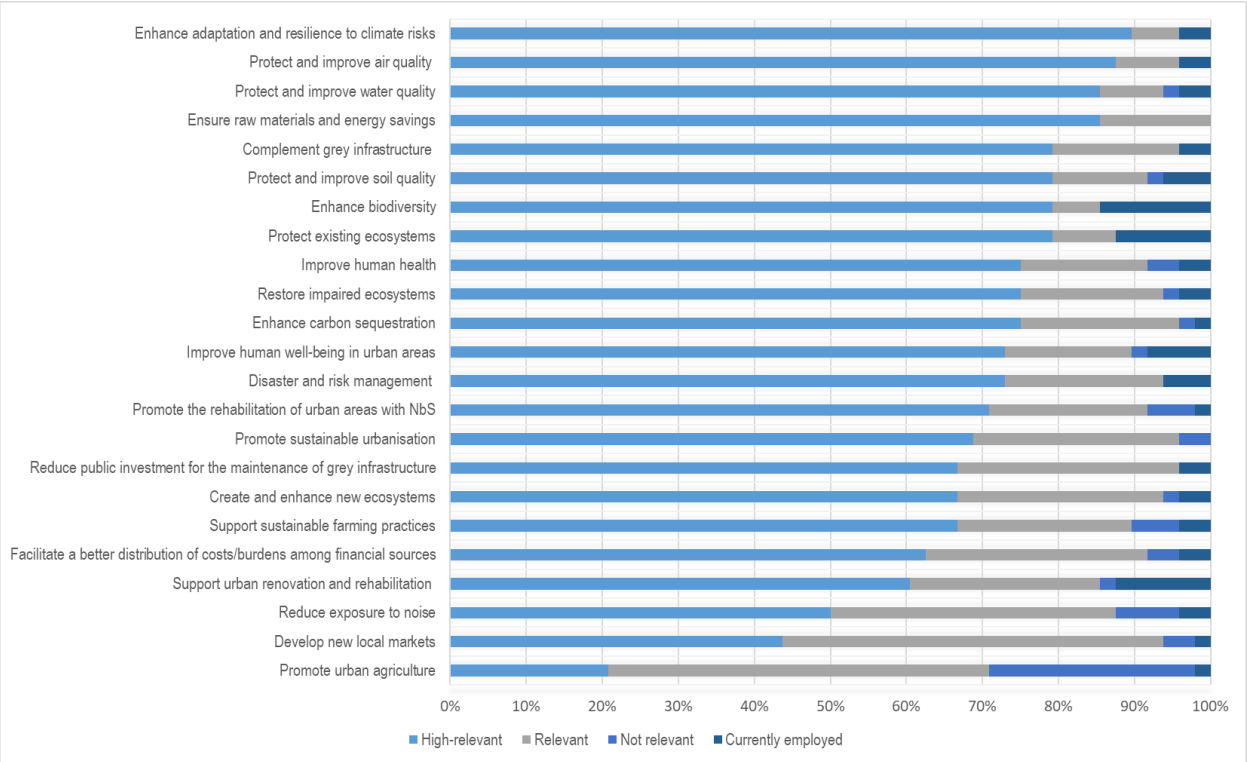
Project/Initiative name	Link	Number of case studies	Hungarian case studies
Hungarian collections			
Green City Hungary	http://green-city.hu/mintaprojektek	31	31
Community gardens	http://kozossegikertek.hu/kertek/	83	83
URBACT	http://www.urbact.hu/partnervarosok	18	18
International collections			
Think Nature Project	https://platform.think-nature.eu/case-studies	101	3
Oppla	https://oppla.eu/case-study-finder	311	8
Naturvation	https://una.city/	1006	22
NWRM	http://nwrm.eu/list-of-all-case-studies	139	3

Source: (Csizmadia et al., 2022[5])

[5] Translated from Hungarian. Local governments could select several answers for this question.

The results of the survey show that subnational governments in Hungary recognise NbS as a relevant tool to address multiple policy goals, especially in relation to climate adaptation and air and water quality (Prime Minister's Office, 2021[16]). Other relevant policy goals are related to natural resource management, climate mitigation, infrastructure, biodiversity, public health and well-being (Figure 2.2.). Around 15% of subnational governments reported using NbS to enhance local biodiversity (restoration of near-natural habitats, e.g., wetlands, dead branches, grasslands), and 13% to protect existing ecosystems. Surprisingly, although 13% (n=6) of subnational governments surveyed also reported already using NbS for urban rehabilitation, a relatively low number (60%, n=29) consider them highly relevant. Nevertheless, NbS are seen as being highly relevant to improve human well-being in urban areas (73%, n=35).

Figure 2.2. Hungarian municipalities' motivations for implementing NbS



Note: Results based on a sample of 48 respondents from subnational governments in Hungary answering the question "What policy goals do you consider most important/relevant for green infrastructure development in your settlement?"
Source: (Prime Minister's Office, 2021[16])

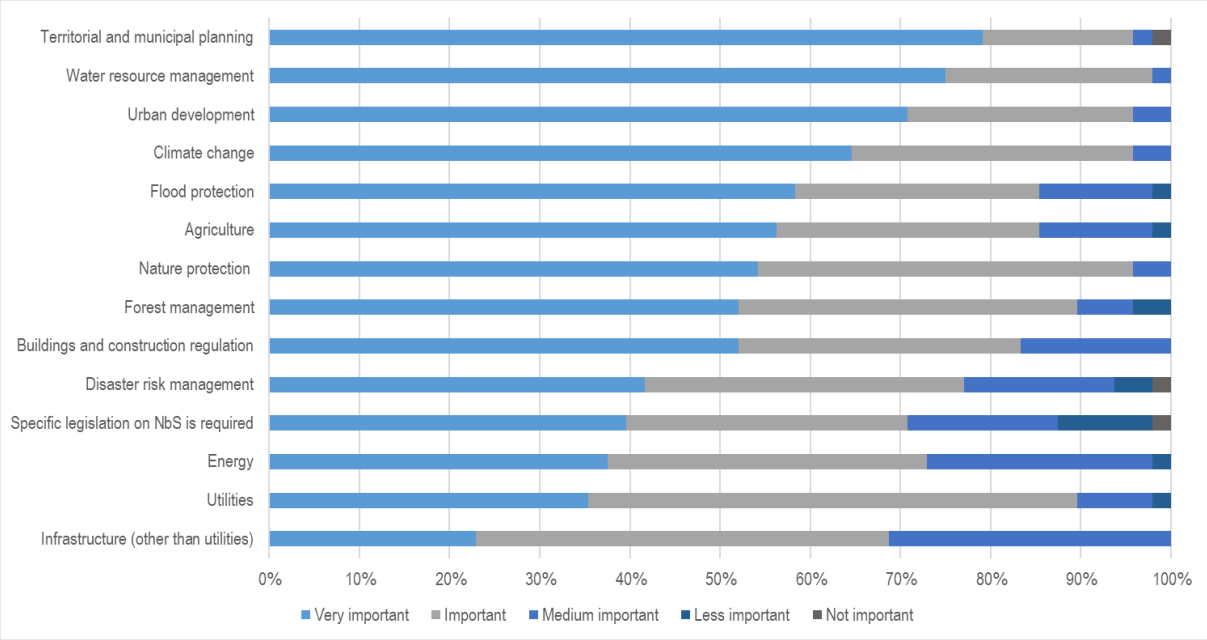
2.2. Drivers of NbS uptake in Hungary

The impacts of climate change are an important driver of Hungarian municipalities' interest in NbS. Extreme heat, drought and heavy rainfall are the most important climate drivers for NbS in Hungarian municipalities: among the 48 municipalities and counties surveyed, 90% (n=44) considered intensified summer heat waves as a "major" or "very serious" problem (Prime Minister's Office, 2021[16]). Other important climate-related issues regard drought or longer dry periods (79%, n=38) and heavy rainfall (79%, n=38). In almost all cases, the frequency and intensity of these three types of extreme weather events is perceived by survey respondents to have increased (Prime Minister's Office, 2021[16]). These extreme weather events affect cities' infrastructure and services by creating energy outages and damaging roads and public spaces, among others.

2.2.1. Spatial planning and water management provide opportunities to implement NbS in Hungarian municipalities

Subnational governments in Hungary view spatial planning and water management as priority areas for NbS. According to the survey, almost 80% (n=39) and 75% (n=36) of subnational governments view 'territorial and municipal planning' and 'water resource management' as "very important", respectively (Prime Minister's Office, 2021[16]). Other policy areas that cities and counties considered as "very important" to foster NbS, are urban development (70%, n=34) and climate change (65%, n=31) (Figure 2.3.).

Figure 2.3. Policy priorities to foster NbS in Hungarian counties and municipalities



Note: Results based on a sample of 48 respondents from subnational governments in Hungary answering the question "Which policy areas do you consider important for the spread of NbS in Hungary?".
Source: (Prime Minister's Office, 2021[16])

Spatial planning has been identified as a key tool to drive NbS in Hungarian municipalities. All three levels of government have a role to play in fostering and promoting the use of NbS through spatial planning. As the entity responsible for defining the planning framework, the national government can amend legislation and enact a National Spatial Plan that facilitate or even promote NbS. County-level plans can be used to set aside land for nature and NbS. Municipalities can leverage regulatory instruments (e.g., prohibitions and plot readjustments) to favour NbS. Expropriation is not generally possible for private developments, but it is for public sector developments that are in the public interest. If a sale of the property could not be negotiated and the proposed development is only possible at the location, expropriation can take place. As such, there is some leeway for the implementation of larger-scale NbS covering land with several owners if the public interest and place-specific dimensions can be proved.

Urban development is one of the main policy areas introducing NbS in Hungary. For example, in Budapest, NbS is increasingly being mainstreamed in urban planning documents such as the Budapest 2030 Long-Term Urban Development Concept, the Smart Budapest City Vision and the Green Infrastructure Action Plan (Dezső Radó). All these policy documents recognise the need to create new or to improve existing green spaces for social and recreational purposes and climate adaptation.

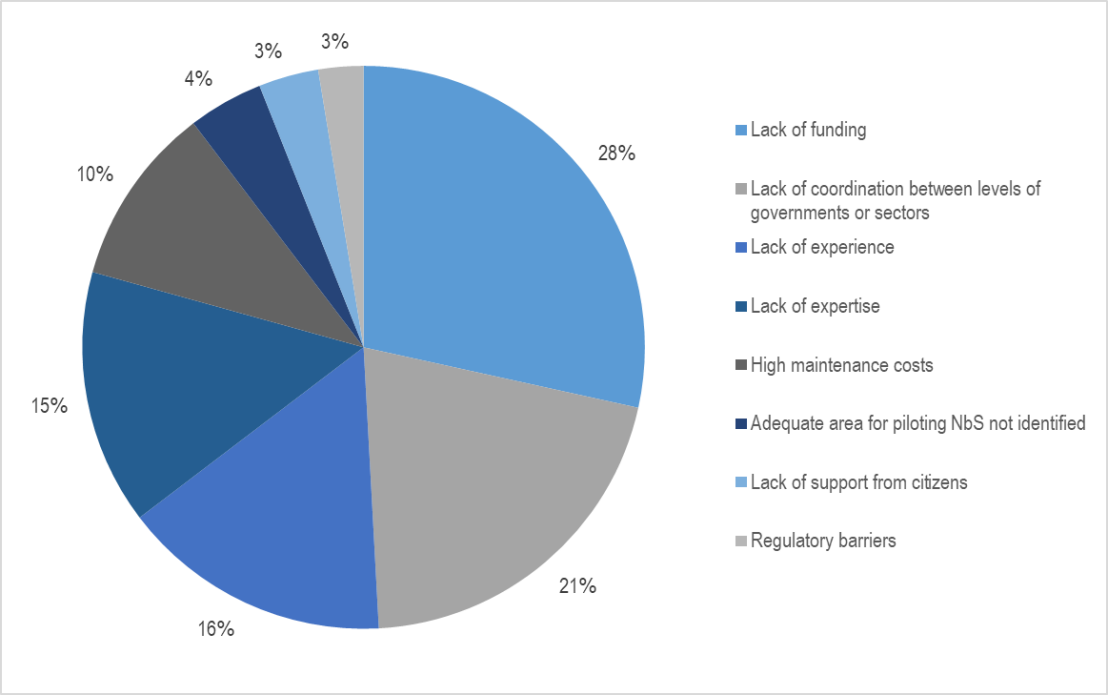
Water resources management has been identified as another key entry point for NbS in Hungary. Hungarian municipalities are increasingly vulnerable to water-related risks exacerbated by climate change and inadequate infrastructure. Flooding from heavy rains and droughts (or longer dry periods) are among the top three climate-related issues that subnational governments reported facing in the survey. Ageing water and sanitation infrastructure and declining municipal investment are also exacerbating water-related risks in Hungarian municipalities.

Responsibilities related to water resources management are spread across levels of government in Hungary, which can hinder effective water governance and implementation of NbS that seek to address water-related risks. At local level, municipalities and water supply and sanitation (WSS) operators are responsible for providing WSS services to the local population. Municipalities and regional waterworks companies discharge and oversee the necessary investments. Regulatory responsibilities are spread out across the Hungarian Energy and Public Utility Regulatory Authority (MEKH), the General Directorates of Water Management and of Disaster Management (supported by 12 and 20 regional agencies respectively), and the National Public Health and Medical Officer Service. At ministerial level, the MIT is the principal ministry overseeing water-related issues in Hungary, but the ministries of Agriculture and Interior also play a role in water policymaking. The Ministry of Interior is responsible for flood management and related regulations.

2.2.2. Major obstacles to the implementation of NbS in Hungarian counties and municipalities

Despite growing momentum for NBS, subnational governments report several obstacles that hinder the implementation of NbS at the local level (Figure 2.4.). The lack of funding was the most frequently cited obstacle, followed by a lack of co-ordination between levels of government or sectors. Capacity constraints, including a lack of experience and expertise are also highlighted as obstacles for NbS at subnational level.

Figure 2.4. Major obstacles for the implementation of NbS in Hungarian counties and municipalities



Note: Results based on a sample of 48 respondents from subnational governments in Hungary answering the question "What do you think are the main obstacles to nature-based solutions?"
Source: (Prime Minister's Office, 2021[16])

The perception that funding is the most important barrier may stem from the strong reduction in the scope, functions and financial resources of subnational governments in Hungary following reforms initiated in 2010, in particular the 2011 Local Government Act (LGA) and the 2012 Constitutional Reform (UCLG and OECD, 2016[43]). This reduction in subnational spending and investment has contributed to broader challenges in funding local infrastructure. First, insufficient funding for secondary and tertiary road maintenance and the lack of local transport options between urban and rural areas has led to a poor quality of local roads and public transport networks (OECD, 2021[44]). This is exacerbated by weather-induced damages to roads, the most frequent damage events in Hungary (36 occurrences per year on average according to the survey) ahead of agricultural crop losses and urban flooding (Prime Minister's Office, 2021[16]).

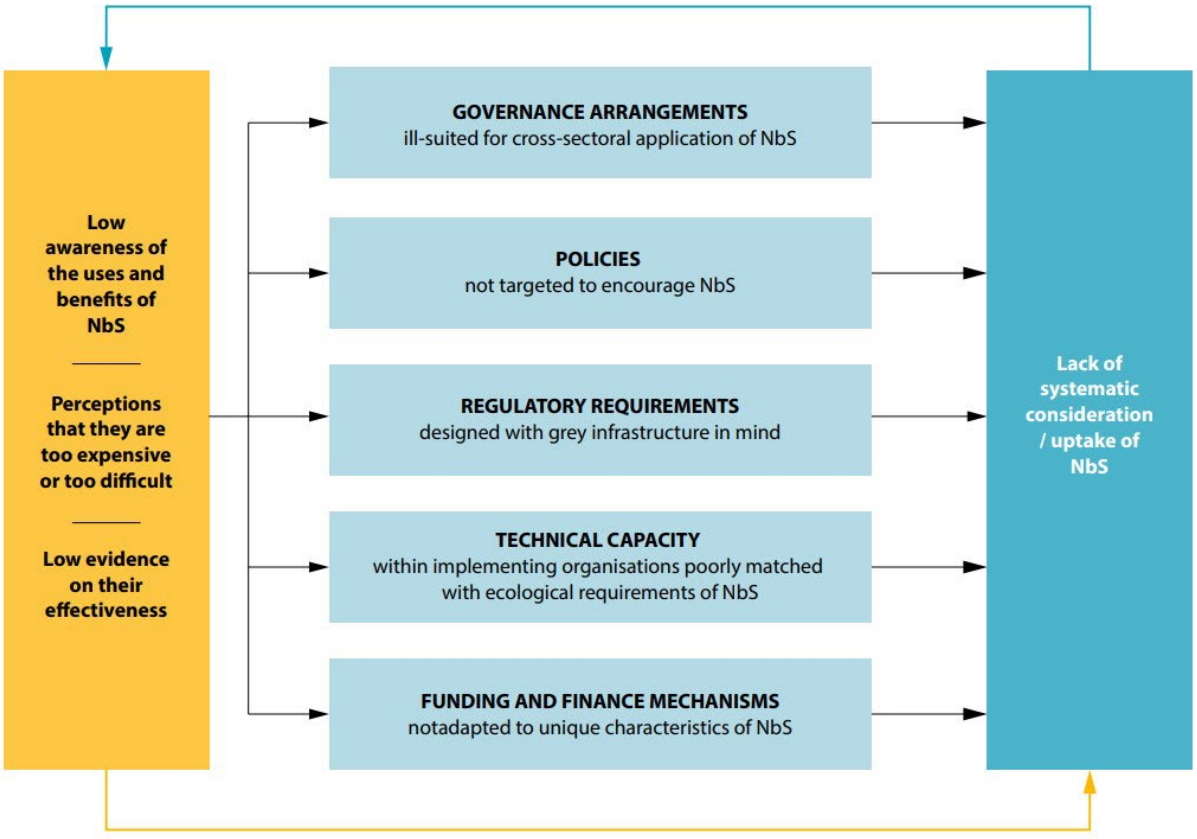
The large number of municipalities relative to population may also partly explain the perceived lack of expertise in NbS at local level, which may lead to knowledge being scattered across municipalities and levels of government. With an average 32.3 municipalities per 100 000 inhabitants, Hungary has the fourth-highest level of municipal fragmentation among OECD unitary countries, similar to the Czech Republic and the Slovak Republic (OECD, 2021[45]). However, the central government's increasing promotion of inter-municipal co-operation[6] led to 83% of Hungarian municipalities being involved in a local government office grouping administrative services as of 2017. Inter-municipal co-operation could provide a vehicle to share expertise and experience on NbS in Hungarian municipalities.

[6] The central government has encouraged inter-municipal co-operation since the 1997 Act on the Associations and Co-operation of Local Government. The 2013 Cardinal Law on Local Governments took a step further and mandated that municipalities of under 2 000 inhabitants regroup their administrative services within local government offices.

3 Strengthening the enabling environment for NbS in Hungary

Nature-based Solutions have different characteristics to conventional modes of infrastructure provision. As such, an enabling environment designed to support conventional infrastructure may inadvertently hinder the use of NbS in municipalities. The OECD's framework for NbS identifies five key areas that need to be addressed to ensure a level playing field for NbS (Figure 3.1.).

Figure 3.1. Barriers to nature-based solutions



Source: (OECD, 2020[17])

The next sections explore the key findings from the research and recommendations for overcoming these barriers.

3.1. Governance arrangements

Responsibilities for planning and implementing NbS are shared across government agencies, including national flood and drought management agencies, public works or infrastructure agencies, infrastructure operators, and regional and local authorities. This means a cross-sectoral and cross-governmental approach is needed for any effort undertaken to raise awareness or enhance technical capacity, as well as to improve the policy and regulatory environment for NbS (OECD, 2021[46]).

Local authorities and communities have a key role to play by incorporating NbS into local land-use planning and adapting solutions to local contexts.

3.1.1. Key elements of the governance arrangements

Hungary has a centralised institutional system. At the national level, legal and policy responsibilities relevant to NbS are spread across government ministries, with key responsibilities sitting with the Prime Minister's Office, Ministry of Agriculture, Ministry of Technology and Industry and the Ministry of the Interior. There is no formal structure for coordinating NbS at the national level.

Hungary is divided into 175 rural districts and 23 city district offices within Budapest. Each district has a district office with responsibility for implementing national policies in the district. The remit of the district offices covers regulation related to most of the topics relevant to NbS including construction, heritage protection, agriculture, transport, environment and nature protection. However, some key responsibilities are still managed separately, notably the water authority is part of the DG for Disaster Risk Management.

Local government consists of counties and municipalities. Sub-national coordination is achieved at the county level or through horizontal cooperation across municipalities (such as through associations of municipalities). Most responsibilities are held by municipalities, with counties being responsible for tasks that cross municipal boundaries. Tasks within the remit of counties include regional planning, the allocation of some funds for rural development, and the management of territorial programmes. In general, municipalities are responsible for land use planning, but this can be overridden by the national government for "projects of national interest".

3.1.2. Key governance issues

Responsibilities and competences related to NbS (e.g., environmental protection, climate adaptation and water management) are divided across ministries in Hungary. The Ministry of Agriculture designs, plans, guides and implements policies for environmental protection and ecosystem services. The Ministry of Technology and Industry is responsible for climate protection and infrastructure development. The Ministry of Interior coordinates water management policies. The Department of Municipal Planning, Spatial Planning and World Heritage of the Prime Minister's Office has responsibilities in the planning, design, maintenance and protection of green areas.

The fragmentation and frequent changes to the allocation of responsibilities between ministries and authorities limits co-ordination. As an illustration, the elements of water management -- water supply, water resources management and wastewater management -- are addressed separately in Hungary. This fragmentation makes it challenging to take an integrated view of the topic.

The lack of horizontal and vertical co-ordination is one of the most important obstacles to NbS according to subnational governments. Budapest and other large cities (50 000-300 000 inhabitants) see this lack of co-ordination across levels of government and sectors as the most important barrier to NbS. Strategies and programmes are developed independently from each other, which limits the efficient and sustainable implementation of NbS. Strategies often show a consistent hierarchy within a sector, but there is a lack of coherence between the different sectoral strategies related to NbS (Csizmadia et al., 2022[47]).

Nevertheless, the national government and municipalities are increasingly recognising *nature conservation* as a key element for regional development and are integrating this into their own programmes and instruments.

There is no overarching institutional framework for NbS in Hungary. The results of the survey highlight that while Hungarian cities and counties recognise their responsibility in implementing NbS, they perceive that the national government plays a key role in providing the necessary policy frameworks and funding (Prime Minister's Office, 2021[16]). In the absence of an institutional framework for NbS, the national development strategy (National Development and Territorial Development Concept), the building code, the climate change strategy (Hungarian National Climate Change Strategy 2008-2025) and the biodiversity strategy (National Strategy for the Conservation of Biodiversity 2015-2020) set the de facto framework for NbS in Hungary.

Although citizen-led urban greening projects (e.g., community gardens) have emerged in Hungary, citizen participation and activism for urban nature in the country are comparatively low (Bulkeley et al., 2020[48]). Limited public consultation in urban planning and a low awareness of climate change and the benefits of NbS are among the main structural conditions of low citizen engagement for NbS in Hungary. Hungarian decision-making processes do not have a tradition of involving civil society, so citizens are not used to engaging in participatory processes, and tend to have a low level of trust in decision-makers and engineers (Csizmadia et al., 2022[5]). Centralised and hierarchical government structure also tends to limit stakeholder engagement.

3.1.3. Main recommendations for governance arrangements

The recommendations focus on clarifying the roles and responsibilities of NbS at national level across sectors and engaging stakeholders in all steps of the infrastructure cycle.

Co-ordinate policies for effective local implementation of NbS

Given the benefits of NbS span across different sectors and cross municipal boundaries, the design and implementation of NbS requires strengthened horizontal co-ordination at national level and vertical co-ordination between the national, county and municipality levels. The government of Hungary can define the roles and responsibilities of relevant ministries, agencies and other public actors to promote NbS at local level. This could be done, for example, by creating a national NbS strategy that defines roles and responsibilities of relevant actors. In addition, the government can facilitate co-ordination among various actors, for example by creating an inter-ministerial co-ordination group to regularly exchange the information on each ministry's strategies, programmes and projects with respect to NbS. Such co-ordination mechanisms, whether they are formal or informal, are crucial to ensure coherence, foster synergies, and thus improve policy effectiveness. The US EPA Green Infrastructure Federal Collaborative initiative has fostered engagement and co-operation between national agencies working towards the promotion of green infrastructure (Box 3.1). Similarly, for NbS addressing water risks, cooperation between water agencies, municipalities, the water management directorate, associations of public road builders, chamber of engineers and architects could be enhanced by creating a working group at the level of river basins.

Box 3.1. US EPA Green Infrastructure Federal Collaborative

The Green Infrastructure Federal Collaborative, led by the US Environmental Protection Agency (EPA), was launched in May 2021. It seeks to foster engagement and co-operation between national agencies working towards the promotion of green infrastructure. The collaborative's members work together to align knowledge and resources to build capacity for green infrastructure implementation, publicising the multiple environmental, economic, and social benefits of green infrastructure. In addition, the Green Infrastructure Federal Collaborative aims to facilitate strategies that foster climate resilience and encourage the equitable implementation of green infrastructure in communities nationwide. Current collaborative members include 8 Federal departments or agencies (Army Corps of Engineers, Agriculture, Commerce, Homeland Security, Housing and Urban Development, Interior, Transportation, and Environmental Protection).

Source: (US EPA, 2020[49])

Engage stakeholders in the design and implementation of NbS at local level

Engaging local stakeholders can provide diverse benefits to local NbS. It can help NbS projects become more cost-effective, better serve the local needs, gain stronger political support, and keep properly operated and maintained. In addition, local NbS need to consider and embed local community needs, aspirations and knowledge in planning to ensure that interventions address underlying inequalities and are supported and maintained in the long term (World Bank, 2021[50]; Bulkeley, 2020[51]; Csizmadia et al., 2022[5]; UNEP, 2021[52]). As local authorities play an important role in promoting and facilitating stakeholder engagement, the government of Hungary should play a role in supporting them taking steps to increase the level of stakeholder engagement in local planning and project mechanisms.

Different levels of stakeholder engagement can be leveraged to meet specific goals. The OECD distinguishes six levels of stakeholder engagement depending on the processes and intentions pursued (OECD, 2015[53]). These range from communication, which aims to share information and raise awareness but implies a passive engagement, to co-production and co-decision, where stakeholders exercise direct authority over decision-making, passing through consultation, participation and representation. OECD work shows that effective stakeholder engagement enables an inclusive and systemic approach to policymaking at all stages, which can result in a higher return on time and resources invested (OECD, 2015[53]). Stakeholder engagement was a key success factor enabling communities to take ownership of Singapore's waterways and water bodies (Box 3.2).

Box 3.2. Partnerships with community groups in Singapore

The Active, Beautiful, Clean Waters (ABC Waters) Programme is a long-term initiative to transform Singapore's waterways and waterbodies beyond their traditional functions of drainage, flood control and water storage into scenic waterscapes and focal community points. In doing so, it expands recreational options and creates a 4sense of collective ownership over water. To encourage the co-creation of ABC Waters projects, Singapore's National Water Agency (PUB) engages the community from the early stages of project development to ensure that the sites are built based on what the community wants, keeps them updated about project progress, and works with them to make the sites more meaningful to the community. Through fostering advocacy and awareness of the water cause as well as adoption of water bodies, the engagement motivates the public community to conserve water and keep catchments and waterways clean so that they can enjoy the recreational opportunities it offers. To date, 321 active partners have adopted ABC Waters sites in Singapore.

Source: (OECD, 2015[53]; UNEP, 2021[52])

A possible step for the government would be to review and improve current stakeholder engagement mechanisms in formal planning processes and related sustainable development strategies. This could build on existing platforms such as the National Council for Sustainable Development, which includes members from NGOs, academia, faith communities, trade unions and civil society, among others (Bulkeley et al., 2020[48]). In NbS projects where the national government plays an important role (e.g., in funding), it should ensure that local governments have sufficient time, financial resources and capacity to engage with stakeholders adequately. Engaging citizens requires not only informing them about the importance of NbS, but also encouraging them to co-design the solutions, thus adapting NbS to the local context (IUCN, 2021[54]). Similarly, municipalities should ensure adequate stakeholder engagement across the project cycle, paying particular attention to the following issues: define mechanisms for local community engagement, map the stakeholders, their responsibilities, motivations and interactions as well as to define the ultimate line of decision making, the objectives of local community engagement and the expected use of inputs (OECD, 2018[55]).

Table 3.1 highlights how stakeholders can be engaged across the infrastructure cycle to achieve different objectives. In Hungary, landowners need to be involved in all phases to ensure the sustainability of the infrastructure and reach the required scale to obtain the different benefits when implementing NbS.

Table 3.1. Stakeholder engagement across the infrastructure cycle

Phase	Objectives of stakeholder engagement and examples of mechanisms
Assessing	Identification of risks to different categories of stakeholders and assets; information provision (e.g., through perception-based surveys) for climate risk assessments and adaptation planning.
Planning	Development of a common vision for the development of resilient coastal infrastructure through consultations and a range of stakeholder engagement mechanisms.
Financing	Enhancement of the willingness to pay for innovative project and identifying new, previously untapped sources of finance (e.g., property developers, insurance companies).
Monitoring	Multi-stakeholder meetings and ad hoc surveys to help monitor social, environmental, and economic impacts of coastal infrastructure, as well as of the stakeholder process itself.

Source: (OECD, 2018[55])

3.2. Policy environment

National policy documents, such as national urban strategies, national adaptation plans or the national biodiversity strategies and action plans, can promote NbS to address climate risks, including those related to water. High-level national strategies can be helpful in setting priorities for NbS, the proposed measures also need to be reflected in the sectoral policies that will be critical for implementation (e.g., agriculture, infrastructure, disaster risk management, tourism, etc.). Policy ambitions need to be tied to concrete targets and monitoring mechanisms if they are to reach their objectives (OECD, 2021[46]). Policies also need to sustain cities of all sizes, through a collaborative process in shared responsibility within and across all levels of government. This should be based on multi-stakeholder engagement of all relevant urban and rural actors, including civil society and the private sector (OECD, 2022[56]).

3.2.1. Key policies relevant for NbS in Hungary

NbS have been promoted in international frameworks including the Sendai Framework for Disaster Risk Reduction, EU Strategy on Adaptation to Climate Change, the EU Flood Directive and a wide range of other international policies and strategies. These policy frameworks set targets for the protection of ecosystems and conditionality for economic activities (Csizmadia et al., 2022[47]).

These international strategies and guidelines have spurred the integration of NbS and other related adaptation measures into domestic policies. Some policies at national and regional level explicitly refer to the use of NbS and other related adaptation measures. Other documents refer to NbS implicitly, by indicating targets related to NbS, such as the conservation of natural ecosystems and climate adaptation objectives (e.g., National Environment Programme, National Framework Strategy for Sustainable Development) (Csizmadia et al., 2022[47]). Box 3.3 provides a list of key policies for NbS.

Sectors such as water management, agriculture, forestry, and transport have included NbS-related targets and measures in their key strategies and plans. For example, the National Water Strategy (Jenő Kvassay Plan) sets objectives that are implicitly related to NbS. As an illustration, the strategy defines long-term goals such as improving water retention, waterlogging protection, risk prevention approaches, improving the relationship between society and water which can be achieved through NbS (Csizmadia et al., 2022[47]). Some other key sectoral policies are the National Rural Development Strategy, National Forest Strategy 2016-2030, Soil Protection Action Plan and the National Transport Infrastructure Development Strategy. These documents include targets and measures related to NbS, even if the documents do not use the term “nature-based solutions”. A list of the NbS-related sectoral plans and strategies is provided in Annex A.

Box 3.3. Policies related to nature-based solutions at the national level in Hungary

The National Adaptation Strategy explicitly mentions the use of NbS for addressing fluvial floods, pluvial floods and droughts. It also provides various risk maps related to climate change (available in the NATéR geoportal).

National Environment Programme (NKP) illustrates the strategic directions for environment policy, while also reflecting on the most important environmental risks in Hungary.[7] Nature-based solutions are reflected implicitly in the programme's emphasis on efficient management of natural resources, energy saving of materials, water, land, land and energy saving. The **National Nature Conservation Base Plan**, which is part of the National Environment Programme, refers to green infrastructure as implementation tools, with the mapping and evaluation of ecosystem services.

National Climate Change Strategy 2 (NCCS-2) encompasses the targets set in the National Decarbonisation Roadmap, the National Adaptation Strategy and the "Partnership for Climate" Perspective plan. Although the document does not use the term "Nature-based Solutions", it refers to other related approaches, such as green infrastructure or ecosystem services and NbS-benefits (e.g. water retention). The document also mentions several NbS-related measures such as afforestation, carbon sequestration and development of natural water supply systems.

National Landscape Strategy 2017-2026 provides a comprehensive approach for the implementation of NbS. The principles of the strategy support NbS through the protection of natural resources and cultural heritage, wise and sparing land use and the promoting climate change and mitigation and adaptation.

National Framework Strategy for Sustainable Development 2012-2024 is a national concept for the transition to sustainability. The aim of the Strategy is to create a comprehensive and coherent framework for policy actions to stimulate investment in the resources of future generations. It focuses on the management of three core "capitals" — social, natural and economic resources.

Source: (Csizmadia et al., 2022[47]; OECD, 2020[17]).

Due to their scale, county and municipal strategies provide more detail on the implementation of NbS, because they are developed to support planning in a catchment, sub-catchment or other landscape areas with specific characteristics (Konkoly-Gyúró et al., 2021[57]). In Hungary, the two main policy frameworks at county level are the County Climate Strategies and County Spatial Development Concepts and Programmes. The County Climate Strategies contain a wide range of principles that promote the use of NbS in form of conceptual plans, targets, measures (Csizmadia et al., 2022[47]). Such elements are usually objectives related to the implementation of green infrastructure, promoting sustainable land use and agriculture, water retention, reducing habitat fragmentation, maintaining ecological corridors, and limiting the spread of settlements by building in surrounding natural areas.

Municipalities often develop their own, local strategies and plans related to climate change adaptation, such as the Municipal Climate Strategies or the Sustainable Urban Development Strategies (Csizmadia et al., 2022[47]). Similarly to regional and county plans, these strategies may present objectives and measures related to NbS. The only documents that contain specific interventions are the local urban development strategies, but they do not identify the potential location of the implementation of NbS.

[7] The 5th National Assembly adoption of the current National Environmental Programme is expected in 2022.

3.2.2. Key policy environment issues

Hungary's national adaptation strategy explicitly mentions the use of NbS for addressing fluvial floods, pluvial floods and droughts (OECD, 2020[17]). Some other national strategies address the need to conserve natural systems, climate adaptation objectives and the development of green infrastructure, and other NbS-related approaches in the context of biodiversity conservation. However, the strategies lack of common and official definitions for the related terms and are used inconsistently across policy frameworks (Csizmadia et al., 2022[47]).

There are inconsistencies between the objectives of these strategies and the selected targets. This has resulted in the implementation of projects that are inconsistent with the strategic objectives of the policy frameworks. For example, the objective of water retention is reflected in several strategic documents. However, projects usually tend to be prioritised based on their ability to drain greywater and wastewater without considering recovery measures. This is mainly due to insufficient cross-sectoral coordination when assigning resources to related operational activities (VTK Innosystem Kft., 2018).

3.2.3. Main recommendations for the policy environment

The government could develop a common statutory definition of Green Infrastructure and NbS to underpin inclusion in relevant policies and strategies. The definition could include detailed construction, operation and maintenance guidelines and minimum scales and benefits required. It could be adopted in the Environment Act and used in national policy frameworks and sectoral legislations.

> *Adopt a common statutory definition of Green Infrastructure and NbS to underpin inclusion in relevant policies and strategies and define responsibilities within governmental bodies.*

A common definition of the term "Nature-based Solutions" could be adopted in the Environment Act and used in national policy frameworks and sectoral legislations. This could be based on the definition adopted by the UN Environment Assembly in 2022[8]: "Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits".

In Hungary, the term green infrastructure has been used for years, albeit with different interpretations. Unlike "nature-based solutions", this is not a new term that has to be integrated to the policy frameworks, but an existing one, which needs a statutory definition, that could be used as a reference point. The framework of the Environmental and Energy Efficiency Operative Programme (KEHOP) research project in 2016 provides a basis for defining green infrastructure, based on the EU's definition. According to the definition, green infrastructure is a "network of natural, semi-natural, and near-natural areas and other vegetation-covered areas with ecological functions and water and coastal ecosystems. Green infrastructure areas are multifunctional resources capable of delivering versatile ecosystem services" (Csőszi et al., 2021[58]). Such definition could be used in subnational and/or sector-specific policies and regulations, like in the case of the U.S.'s Water Infrastructure Improvement Act, which refers to a statutory definition of green infrastructure (U.S. Congress, 2019[59]).

Based on the EU's definition on NbS and green infrastructure and on other countries' (e.g. United States, United Kingdom, Slovak Republic) the common statutory definition of the terms NbS and green infrastructure could contain the (1) general overview of the term, (2) the objectives that could be reached by the implementation of these solutions, (3) the potential benefits (environmental, economic, social), (4) the linkages and differences to other related terms and (5) examples of actual measures. In addition to

[8] UNEP/EA.5/Res.5 - Proceedings, Report, Ministerial Declaration, Resolutions and Decisions UNEA 5.2 (unep.org)

NbS and green infrastructure, terms such as natural capital and ecosystem services could be also defined and used consistently across policy documents and adjusted in subnational or sectoral legislations (Csizmadia et al., 2022[47]). The different types of NbS and green infrastructure could be also listed (for example in the glossary of the Climate Change Strategy of Hungary) and defined. Such lists for the different types of NbS are used in Sweden's national guideline on NbS or in the U.S. Environmental Protection Agency's definition on green infrastructure (Swedish EPA, 2021[60]; US EPA, n.d.[61]). The definition can also be accompanied with leading examples of NbS already in place in Hungarian municipalities to illustrate the potential of scaling-up such practices.

3.3. Regulatory environment

The regulatory framework, which includes building codes, land-use regulation, permitting, procurement policies and environmental protection regulation, has a major impact on project decisions taken by local governments and non-governmental actors.

3.3.1. Key elements of the regulatory environment

Existing regulatory instruments provide municipalities with several opportunities to identify target areas for NbS (urban planning, ITVT) (Csizmadia et al., 2022[47]). According to the survey, most local governments (73%, n=31) already have in place a strategy, plan, local regulatory tool related to the development of municipal green-blue infrastructure (Prime Minister's Office, 2021[16]). All counties that responded have at least one instrument in place. The most common instruments used for NbS are the Integrated Urban Development Strategy (ITS in Hungarian), the City Climate Strategy and Sustainable Energy and the Climate Action Plan. Other instruments used to implement NbS are local ordinance, urban planning including NbS, Green Infrastructure Development and Maintenance Action Plan (ZIFFA) and green surface system plan.

The following section introduces the main characteristics of the sectoral regulations and highlights the key regulatory barriers to the implementation of NbS for land use, environment, water, nature conservation and transport.

Land use planning

The planning levels of land use are (1) national, (2) priority areas (including the Balaton Featured Resort Area and Budapest Agglomeration), (3) county and (4) municipal levels. At each level, a development plan outlining conceptual objectives and a plan for the use of specific areas adopted by law have been developed (Csizmadia et al., 2022[47]).

According to the regulations, territorial plans should ensure sustainable development and be consistent with environmental objectives (Csizmadia et al., 2022[47]). Spatial planning can provide a framework for planning beyond the administrative boundaries of settlements, which is an essential element in the case of natural resources such as water and soil. In practice, it can lead to measures such as watercourse revitalization, water reservoir and erosion protection interventions across administrates boundaries (Csizmadia et al., 2022[47]).

Several national plans help to define the regulatory basis for spatial planning:

- The National Development and Territorial Development Concept defines the key long-term goals for territorial planning (e.g., sustainable use of natural resources). It also sets out specific objectives that have to be implemented in policies (e.g. conservation and sustainable use of strategic resources) (*1/2014. (I. 3.)*, 2014.).

- The National Spatial Planning Plan, which defines the framework for lower-level spatial and urban planning plans. Plans demarcate land-use areas (forest management, agricultural areas, etc.) and define the infrastructure network elements. It also defines protection zones that are important for land use (e.g. proposed areas for afforestation, water quality protection zones), while at the priority area and county level, it sets out more specific zones and goals (e.g. vine, landscape protection areas) (*9/2019. (VI. 14.)*, 2019; *CXXXIX. Act*, 2018).
- The Green Infrastructure Development Plan provides the basis for reviewing, updating and restoring this zone using the condition assessment, risk analysis and the designation of restoration target areas based on the Environmental and Energy Efficiency Operative Programme (KEHOP) Green Infrastructure research ("KEHOP-4.3.0-VEKOP-15-2016-0001," 2016).

The following regulatory tools support NbS implementation and limit ecosystem losses: (1) the designation of a new built-up area must be accompanied by the creation of at least 5 % of green space or woodland for conservation purposes, (2) settlements cannot be merged, a 'green' strip must be maintained between them, (3) settlements can only be expanded for purposes for which there is no suitable area or brownfield within the settlement area; (4) no areas for development may be designated in certain areas of the ecological network and in the forest zone (Csizmadia et al., 2022[47]).

Urban planning regulations contain numerous tools that can encourage investors to develop NbS and help internalise the natural effects of new investments such as setting a higher required minimum green area ratio than the national regulation, obligation for the implementation of green roofs or multi-level vegetation. For example, the Kecskemét settlement has introduced regulations for rainwater retention and local treatment methods in their local regulation. Szeged municipality regulates building development more strictly than the national regulatory framework, with specific regulations to protect green areas and retain rainwater (Csizmadia et al., 2022[47]). However, these examples remain the exception rather than standard practice.

Water regulation

Currently, territorial water management and rainwater management fall under different regulations.

Territorial water management focuses on the use of water, the preservation of water and flood defense and protection against water damage (water damage control) (*P.22. of Annex to Act LVII.*, 1995). The regulatory environment of the current water management framework primarily serves the objectives of protection against water damage and non-harmful derivation. Nature-based solutions can help to comply with the regulations targeting water management at municipal level. For example, local authorities are obliged to protect against water damage in municipal areas (*Section 4.§ (1) b) of Act LVII.*, 1995).

Responsibility for stormwater management is shared between several actors. Property owners are responsible for the runoff from their plot, local governments are responsible for public spaces in the inner settlement area, and water directorates are responsible in the outer municipality areas (Csizmadia et al., 2022[47]). The related legislative and coordination tasks are also shared among the Local Government Secretariat of the Ministry of the Interior, the Deputy State Secretariat of the Ministry of Internal Affairs and Water and the Hungarian Energy and Public Utility Regulatory Office (Csizmadia et al., 2022[47]). The Water Management Act provides the legal framework for the transitioning from water drainage to water resource management, which can be enforced through the related decree amendments and existing regulations (Csizmadia et al., 2022[47]).

Nature conservation regulation

The Environmental Protection Act sets green space management as a mandatory element of the municipal environmental protection programme (*LIII. Act on the General Rules for the Protection of the Environment*,

1995). In addition, it indicates that municipal council can create rules restricting ownership by municipal decree to protect certain woody plants not covered by another law (Csizmadia et al., 2022[47]).

Protected sites are managed according to the conservation management plan and Natura 2000 site maintenance plans. In addition, municipalities can declare protected sites or monuments of local importance protected via local decrees. In that case, the municipality oversees the planning, management, and administrative obligations (Csizmadia et al., 2022[47]).

Transport regulation

The transport sector is regulated through national guidelines for planning and maintenance of roads. For example, the Transport Identity Manual A handbook has been produced by the Chamber of Engineers (Budapesti és Pest Megyei Mérnöki Kamara, 2017). Municipalities are responsible for road regulation in urban plans and protecting the road against weather conditions and its aesthetic design (Csizmadia et al., 2022[47]).

3.3.2. Key issues of the regulatory environment

The use of NbS and other related approaches are often highlighted in key policies, however this does not always translate into regulatory frameworks.

Spatial and municipal plans contain rules that support the protection and development of green infrastructure. However, they tend not to reach their objectives due to common use of exceptions and regulatory loopholes. This is the case for ecological network zoning, restrictions on the designation of land for development and biological activity value calculation. In addition, the current regulation framework is missing the connection between biological activity value and green infrastructure planning (Csizmadia et al., 2022[47]).

Similarly, risk management is addressed through regulatory instruments such as the green infrastructure development plan or the municipal rainwater management plan. Both plans are present in the Hungarian legal system, but the relevant regulatory instruments do not provide detailed content requirements for NbS. For example, the Prime Minister's Office published a guidance for municipalities on how to develop their own Green Infrastructure Development and Maintenance Action Plans (e.g. Budapest's Green Infrastructure Action Plan (City of Budapest, 2021[62]), but without defining specific NbS-related requirements.

The current authorisation procedure for technical planning and implementation makes the use of NbS difficult, particularly for smaller bioengineering interventions. For example, the concept of small-scale watercourse management is not present in the current regulatory environment (*1995 LVII. Act on Water Management*, 1995). In addition, a waterbody can only have one function in its operating license, which hinders the recognition and uptake of the multifunctionality of a small-scale water facility (Csizmadia et al., 2022[47]).

The lack of clarity in the current regulation limits the combination of infrastructure and NbS. While there are required protective distances for infrastructure, green area elements (existing trees, tree rows) do not have any. The lack of regulation creates a situation that may lead to the destruction of the wood line because it is within the protective distance of the new infrastructure (Bardóczi Sándor et al., 2018). In addition, no regulation has been developed for landscape protection.

For water management, national and county-level Spatial Planning Plans do not designate flood protection or water retention zones, which could provide area for NbS. Currently, there is no municipal strategy document that addresses both the issues of urban rainwater management and land use (Csizmadia et al., 2022[47]).

For soil, the regulatory framework is incomplete for both soil protection and erosion protection. For example, Act CXXIX of 2007 protects arable land, but it is not accompanied by a government decree and ministerial decree supporting its implementation. The sanctions for additional soil load resulting from water erosion are the responsibility of the soil protection authority. Municipal authorities and water utility operators who are the most affected by water erosion do not have any sanctioning power.

3.3.3. Main recommendations for regulatory environment

The following section presents the priority recommendations related to regulatory reforms which could be considered in the short term.

Adopt revised national and subnational procurement policies and project selection criteria to encourage the use of green solutions by considering lifecycle costing and social benefits for infrastructure projects

The national and subnational procurement rules and project selection criteria applied in case of EU and national funding decisions could be reviewed to capture the indirect benefits of NbS to nature and human health such as increased biodiversity, flood protection and improved air quality. This could be done by increasing the weighting of environmental criteria[9] within public procurement and project evaluation, including cost-benefit analysis of ecosystem services considering externalities and the full life cycle and monitoring indirect and direct environmental impacts (Csizmadia et al., 2022[47]).

Capacity constraints within municipalities prevent them from assessing the wider benefits of NbS (such as social, environmental). As a result, the economic and financial case may often be difficult to demonstrate. Therefore, supportive policies can develop the strategic case for NbS proposals. As illustrated by the Spanish case in Box 3.4, the modification of the public procurement law could incentivise NbS by including environmental and social indicators (European Commission, 2020[63]). In addition, the timeframe for procurement could be extended to allow for the additional activities required to ensure nature conservation and protection, cross-sectoral coordination, cost-benefit analysis and stakeholder engagement (Csizmadia et al., 2022[47]).

Box 3.4. Spanish Public Procurement Law incentives for Nature-based Solutions

The Spanish Public Procurement Law (2017) aimed among others to facilitate public-private partnership, increasing available funding and expertise for urban NbS. It increased the duration of permitted contracts between public and private entities, which enables the latter to gain a better return on investment in NbS, which often deliver value over long time horizons. It incentivises investment in high-quality NbS with higher post-implementation returns. In addition, the new law also obliges contracting bodies to design award criteria around quality, specifically by including environmental, social and innovation indicators.

Source : (van der Jagt, 2020[64])

The development of standardised and localised NbS key performance indicators throughout the infrastructure life cycle could encourage the adoption of good practices in Hungarian municipalities. These indicators would measure environmental, social, and economic performance thereby enabling municipalities to better assess NbS values. Key performance indicators would also help to convert the

[9] DG Environment has published voluntary green public procurement criteria that public authorities can choose to adopt for different kinds of products and services in the procurement process (van der Jagt, 2020[64]).

effects of NbS into monetary terms. For example, the expected performance of NbS in terms of energy savings, health expenditure savings, and flood mitigation savings could then be transferred into the contractual agreements for service suppliers such as roads and water utilities, following a "performance-based" contract model.

NbS procurement could also be grouped to increase contract values. Municipalities may face difficulties in finding suppliers willing to develop NbS when contract values are low, given the potentially higher transaction costs. Where possible, grouping several small contracts together in a single call for tender, or where possible allowing suppliers to enter a framework agreement for NbS, may provide suppliers with an incentive to better engage with such projects. Collaboration between municipalities could be used for joint procurement of NbS projects. This would increase contract value and give suppliers an incentive to participate in a call for tenders (European Commission, 2020[63]).

Strengthen planning and development frameworks at county and municipal level to have an integrated land, soil and water management strategy that fosters water retention in soils

In Hungary, NbS are not routinely considered as part of strategic spatial planning approaches such as urban development, nor included in land, water or climate adaptation plans, although the needs and potentials are well recognised, as highlighted in the survey results. Spatial development plans at national, county and municipal levels do not always integrate water management and land use, failing to address water retention in urban green spaces (Csizmadia et al., 2022[47]). In addition, the Green Infrastructure Development and Maintenance Action Plan (ZIFFA) does not fully recognise the importance of water retention and erosion reduction. Another clear challenge is a lack of regulatory frameworks for protecting nature. While regional and local spatial planning and development framework often state nature conservations, they rarely have concrete targets or actionable goals. In terms of water retention, there is no jurisdictional power for municipalities or water utility operators to manage soil protection, it is a different responsibility of the national government.

The adoption of risk-sensitive land-use policies could help to guide urban planners to designate specific zones for flood protection and water retention. Vulnerability and risk assessment tools and methodologies can support this effort and prevent urban population and economic activities from locating in the most risk-prone areas. In Sweden, for example, all counties, municipalities and other local authorities are required to carry out a climate risk and vulnerability assessment (Box 3.5).

Box 3.5. Risk vulnerability assessment in Swedish municipalities

In 2018, the National Strategy for Climate Change Adaptation introduced two amendments to the Planning and Building Act (2010:900). First, it mandates all municipalities to assess the risk of damage to the built environment from flood, erosion and landslides, as well as how such risks may change in the future. Second, it requires municipalities to prepare a detailed plan when issuing a land permit for measures that may impair the land's permeability. In this context, Swedish municipalities are identifying concrete opportunities to pilot nature-based solutions to address such risks and integrate them into planning frameworks. For example, in Malmo where growing number of buildings adopting green roofs to increase rainwater retention.

Source: (European Environment Agency, 2020[65]; Government of Sweden, n.d.[66])

The country's demographic patterns highlight the need to consider a "place-based approach" when planning NbS. For example, the higher population density and lower availability of land in Budapest implies that the city centre and the rest of its territory, Pest (the fastest-growing region in Hungary) will need a very

different NbS strategy to the rest of the country. The capital region strategy might favour multiple small-scale projects on existing constructions (e.g., green roofs), minimum requirements for green spaces in new constructions, and NbS outside of the city itself (e.g., restoring ecosystems upstream on the Danube). Nantes Saint-Nazaire in France is implementing measures to integrate water management and land use (Box 3.6).

Box 3.6. Nantes Saint-Nazaire, France – protecting water and encouraging compact and interconnected communities

The cities of Nantes and Saint-Nazaire are in north-western France on the Atlantic coast in the Pay de la Loire region. Together with their surrounding communes, they comprise the 6th largest urban conurbation in France in terms of population. By 2017, the commune of Nantes was the 6th largest city in France, with a population of about 900 000, while the commune of Saint-Nazaire is much smaller, with a population of about 70 000.

Between 2006 and 2018, the metropolitan area experienced a period of sustained growth in population and economic activity. This pattern of population growth led to growing anxiety about the implications for sustainable development, including an increased concern about rapid land conversion and its implications to water management given its proximity to the Loire estuary, which had always been a strategic link between the two cities. However, it had always been thought of in terms of shipbuilding and port activities, and not for housing or businesses. Today, development projects are focusing on creating truly sustainable “micro-cities” that encourage people to live and work at the water’s edge. During the last decade, both cities have developed projects that reflect a common model: an urban area supported by compact, interconnected communities where the riverfront provides structure for the city and prevents sprawl, protecting natural spaces from urban infringement. This city model makes efficient use of space, energy and natural resources.

Source: (OECD, 2017[67]; Pôle métropolitain Nantes Saint-Nazaire, 2015[68])

There are also opportunities to develop local adaptation plans, aligning with the objectives of the National Adaptation Strategy. Currently, Budapest is leading the way towards a better integration of NbS in strategic planning, but still does not have a municipal explicit national adaptation plan. In the Netherlands, the development of City Climate Adaptation Deals has provided opportunities for municipalities interested in implementing climate adaptation measures to collaborate (Box 3.7).

Box 3.7. Strengthening subnational climate adaptation in the Netherlands through Climate Adaptation City Deals and the Climate Adaptation Incentive Scheme

The Climate Adaptation City Deal

The Climate Adaptation City Deal was a four-year (2016-2021) agreement between 37 partners, including 10 municipalities. To identify and pilot innovative solutions to make cities more resilience to extreme weather events, the Climate Adaptation City Deal engaged civil society organisations, business and academia, as well as national and subnational government officials to co-create and implement projects to demonstrate the potential benefits of green infrastructure. Participating cities (The Hague, Amsterdam, Eindhoven, Dordrecht, Rotterdam, Breda, Zwolle, Amersfoort, Deventer and Groningen) are particularly vulnerable to floods. As a result, most of the pilot innovative solutions aimed to adapt to this hazard. For instance, the construction of permeable pavements in Breda (Noord-Bradant) is increasing green public spaces in The Hague (Zuid Holland), the reconversion of an industrial area into a climate-adaptive urban district in Groningen, and the development of a flood risk profile in Amsterdam. All the implemented initiatives concluded that to be effective it is important to first identify the environmental risk areas to better understand needs, as well as to adjust the planning frameworks facilitating the scaling-up of such solutions.

Climate Adaptation Incentive Scheme

In 2018, the national government, provinces, district water boards, and municipalities in the Netherlands signed the *Administrative Agreement on Climate Adaptation*, under which they seek to give impetus to the implementation of measures scheduled in the Delta Plan on Spatial Adaptation. With effect from 2021, the national government is making available a maximum of EUR 300 million, which is matched by another EUR 300 million from the local and regional authorities. As part of the EUR 300 million, the national government is setting aside EUR 200 million for the *Climate Adaptation Incentive Scheme*. This scheme qualifies municipalities, provinces, and district water boards for national government grants to implement climate adaptation measures, namely to address waterlogging (or excessive groundwater), heat, drought, and flooding. To be eligible to receive funding, projects need to be designed based on the results of a stress test and risk dialogues, which requires and open consultation with community stakeholders. The results of the stress test and risk dialogues should be publicly available in a national monitoring platform. Furthermore, the municipality should co-finance two-thirds of the total investment, while the national government provides the remaining.

Source: (Kennisportal Klimaatadaptatie, n.d.[69]; Kennisportaal Klimaatadaptatie, n.d.[70]; Climate Finance Advisors, 2021[71])

An integrated land, soil and water management strategy could be embedded in the urban green infrastructure planning, e.g. through the Green Infrastructure Development and Maintenance Action Plan (ZIFFA) (EHÁT, 2016[72]) or an ecosystem service-based Green Infrastructure Development Plan. The Green Infrastructure Development Plan, developed in coordination with nature conservation policy, could identify action areas, where ecosystem services could be restored with NbS (Csizmadia et al., 2022[47]).

Revise regulations to favour increased water retention in the built environment

The potential contribution of green areas to environmental protection and human well-being is not yet fully recognised in Hungary. Green areas are not adequately valued and are mainly seen as potential areas for future urban development. Architects and urban planners often refer to them as “problematic sites” in terms of settlement structure and site design because they are difficult to build on, with low footprints and irregular

shapes. Furthermore, the maintenance of green infrastructure is not always considered, there are not strict regulations for maintenance of green areas (Csizmadia et al., 2022[5]).

A minimum space of green infrastructures such as green roofs in buildings and the use of permeable and porous pavements for new constructions and renovations could be integrated in a stand-alone chapter of the zoning plans and building codes. Both requirements can be beneficial for water retention. However, its enforcement should be ensured to obtain the expected benefits over time.

Minimum requirements for urban developments to ensure green spaces in development sites and infrastructure could be introduced (e.g., x % of all sites should be kept for green space). This could be applicable for all sectors, with particular focus on buildings, transport infrastructure and water and sanitation. Hungary can take inspiration from Madrid and Boston, which are introducing regulations and incentives for permeable surfaces (Box 3.8).

Box 3.8. Introducing permeable materials: Madrid (Spain) and Boston (United States)

Sustainable Urban Drainage Systems in Madrid (Spain)

Sustainable urban drainage systems (SUDS) were almost unknown in Spain two decades ago; today, urban drainage in the country is transitioning towards a more sustainable and regenerative management. The regulatory framework has shown considerable developments at the local and regional level, driven by the promising results achieved in pilot experimentations. Many cities and regions are developing their own regulations and guidance on SUDS. For example, in 2006, the City of Madrid introduced an ordinance that establishes a minimum threshold of permeable surfaces in public spaces, differentiating pavements (20% minimum permeable surface) from streets (50%) and squares and parks (35%). The ordinance requires development projects to indicate the percentage of permeable surfaces in the network of open spaces on the land to be developed. In 2007, the City developed a technical guide to facilitate the uptake of the regulation by providing concrete examples of how SUDS can be designed and built.

Source: (Bulkeley et al., 2020[48])

Porous Alley Project in Boston (United States)

Between 2013 and 2015, the City of Boston implemented a pilot nature-based solutions project tied to roads, mostly involving the installation of porous asphalt to increase the permeability of pavement and underground water storage. The project was co-financed by the Massachusetts Department of Environmental Protection and the City of Boston. Porous asphalt was applied in streets and alleyways to recharge groundwater levels, in turn reinforcing the structural integrity of nearby buildings, while cleaning and filtering runoff to prevent pollution of the Charles River. Thanks to the successful results of the pilot project, the City of Boston has been introducing and prioritising the use of in the construction of sidewalks.

Source: (Urban Nature Atlas, 2022[73]; Boston Public Works Department, 2013[74])

The following reforms would help to promote and increase water retention in the built environment through regulations:

- Adjust building codes and zoning plans to encourage water retention rather than emphasising drainage, while taking into account the Water Damage Mitigation Plan at municipal level.

- Review the National Urban Planning and Requirements (OTÉK) by: (1) defining the competences needed for the implementation of NbS and (2) reviewing the framework's minimum percentage for green-grey area ratio.

The minimum green area could be the starting point for planning, and the remaining area should be used for the building and the necessary structures (road, parking, pavement, etc.). The framework currently sets out a minimum percentage for green area ratio and a maximum for the built-in area. However, sealed surfaces (parking lot, road, pedestrian ways) are not counted, which are partially required by the regulations. Another option could be to define a maximum percentage of public spaces which can be asphalted in the municipal area.

3.4. Technical capacity

In Hungary, limited technical capacities within implementing organisations are among the major barriers to the uptake of NbS. As mentioned above, this is linked to the small average size of Hungarian municipalities. The following section introduces the key elements of the available technical capacities and the key constraints, with the related recommendations that can help to build and strengthen the technical capacities at different levels, therefore facilitate the use of NbS.

3.4.1. Key elements of the enabling environment for technical capacities

In general, there is limited technical capacity within Hungarian municipalities for NbS, albeit with pockets of expertise in some municipalities. Municipalities usually implement projects including NbS only if they have the expertise needed to design and implement it (e.g., landscape architect, ecologist, environmental economist, urban planner, environmental engineer, water engineer) (Csizmadia et al., 2022[47]). The survey results showed that only municipalities of large cities can afford to employ NbS experts for the design. Small cities and villages have to outsource planning tasks, resulting in higher costs (Prime Minister's Office, 2021[16]).

An important element for building technical capacity is knowledge-sharing, awareness raising and sharing of good practices, in particular for unexperienced municipalities. Hungary is in the early stages of the introduction of NbS, having a quick development of small-scale projects (Csizmadia et al., 2022[47]). Based on the survey results, a quarter of the municipalities have projects that could be a good example of developing green and blue infrastructure in other municipalities (e.g. LIFE MICCAC, community gardens, extensive grassland management, green space linked to cycling paths) (Prime Minister's Office, 2021[16]).

Several online platforms are currently available for sharing experiences: for example, the URBACT platform works with a bottom-up approach and focuses on topics that interest cities, with a particular focus on knowledge transfer (Csizmadia et al., 2022[47]).

3.4.2. Key technical capacity constraints

The results of the survey show that there is a need to improve knowledge of NbS in all relevant areas (state decision-makers, municipalities, authorities, planners, and contractors) (Prime Minister's Office, 2021[16]). The knowledge of those involved in NbS, being a decisive factor in the quality and cost-effectiveness of NbS projects, varies across projects.

Hungary has taken significant steps in digitalising planning data and the whole urban planning process, but many databases required for planning are not freely accessible. NbS monitoring data are not publicly available (Csizmadia et al., 2022[47]). Critical data for planning NbS include: (i) planning information about the local environment (position and condition of the urban and natural environment); (ii) estimated future environmental and climate challenges; and (iii) costs data.

Currently, there is still a lack of free geospatial databases to inform urban planning (e.g. runoff models, water deficit monitoring databases). For example, the National Adaptation Strategy created various risk maps related to climate change (available in the NATéR geoportal), which provides valuable information. Nevertheless, the two applied climate models' results are often contradictory, and the resolution does not allow the use for more detailed planning (Csizmadia et al., 2022[47]). Many of the available databases are not freely accessible. Some spatial data are available for municipalities free of charge. However, most of data sources are still divided across multiple organisations, and the data request process and the pricing are not always clearly communicated. Databases and maps are often incompatible and require extra time and costs for planners (Csizmadia et al., 2022[47]).

There are currently no public guidelines and indicators for monitoring projects. In general, NbS projects lack continuous data collection and data management, due to unclear responsibilities on-site and insufficient resources for coordination and data process, together with the absence of a national unified, freely accessible database (Csizmadia et al., 2022[47]).The lack of data and harmonised assessment systems have a negative impact on municipalities planning and strategies, operating with tight deadlines for planning and lack guidelines to assess the quality plans (Csizmadia et al., 2022[47]). It also impacts the implementation at local level. Achieving potential positive benefits and their sustainability depend on the quality of implementation and operation. The planning, authorisation, operation, monitoring, and control processes of NbS and the production of NbS living materials are missing a clear, unified methodology (Csizmadia et al., 2022[47]). Some could be developed in a short time, others still require data collection or research.

Training in NbS is increasingly being integrated into university curricula and post-degree expert training, but the NbS-related education materials are not harmonised. There is a lack of training programmes for construction experts, employees and employees of municipalities and authorities (Csizmadia et al., 2022[47]). In addition, the Hungarian Chamber of Engineers, the Chamber of Hungarian Architects and the Chamber of Agriculture play a significant role in professional training. However, there remains scope to harmonise the training by different professional associations (Csizmadia et al., 2022[47]).

3.4.3. Main recommendations for capacity building

Building institutional capacity and awareness for NbS is a key element for adjusting the enabling environment and scaling up NbS use across the country. Access to targeted support and mentoring could significantly increase NbS awareness and projects containing NbS at municipal level, particularly for small settlements with limited capacity.

Create a national Competence Centre on urban planning, including Nature-based Solutions, as a one-stop-shop for municipalities to access relevant information and build capacity

A Competence Centre for urban planning could be established to connect municipalities and key stakeholders (such as businesses, academia and community associations), share innovative projects and good practices and provide know-how guides for urban strategies and their implementation. The main objective of the Competence Centre could be to provide the knowledge and assistance that municipalities need for the implementation of NbS. The Competence Centre could also be an interface between the public and private sector, science and research, connecting a wide-range of stakeholders, and gathering information to create a Hungarian NbS-hub. It could also provide NbS training for municipalities, in particular for urban planners.

The development and operation of the Competence centre, including other activities related to awareness raising and knowledge sharing could be financed through available EU funds, such as the Interreg Central Europe 2021-27, LIFE, European Urban Initiative or national operational programmes (Németh, Kravalik and Séra, 2022[75])

An initial assessment of municipalities' needs could be carried out to identify the specific information required and what specific support the Competence Centre could provide. This activity could help to define and fill the existing knowledge gaps. However, needs could vary over time depending on municipalities experience and expertise with NbS, as well as the scale of the NbS implementing, therefore the assessment could be done on a regular basis. The assessment could be done by the Prime Minister's Office and reviewed with the support of the Coordination Office for Municipalities.

To support municipalities in the implementation of NbS, a national online platform could be developed by the Competence Centre. Hungary-specific information and examples would be the priority, in particular to collect and promote them with the online platform. According to the survey results, a quarter of municipalities have projects that could be a good example for developing green and blue infrastructures in other municipalities (e.g. LIFE MICCAC, community gardens, extensive grassland management, green space linked to cycling paths) (Prime Minister's Office, 2021[16]). This shows that good practices are likely to spread from city to city if tangible results can be proven at the local level. Committed mayors and politicians could act as "leaders" in the region by presenting the results of NbS projects and sharing lessons and experiences, potentially through this platform.

The platform could group relevant datasets to: (1) support the assessment of local climate risks and hazards; (2) provide practical guidance for implementing NbS; (3) collect policies, regulations and available funding, that are relevant for the implementation of NbS (4) provide an inventory of national and international case-studies; (5) list relevant contacts. Other categories could be added, based on the municipalities' needs, therefore a close co-operation is required with the Coordination Office for Municipalities, to address and evaluate these needs. Those categories are based on the content of other countries' national NbS platforms. For example, France's Ministry of Ecological Transition and Territorial Cohesion has a dedicated page for NbS on the website of the ministry, while in case of Sweden, the Swedish Environmental Protection Agency has a website, collecting all the relevant information and tools for the implementation of NbS (Swedish EPA, n.d.[76]; Ministry of Ecological Transition and Territorial Cohesion of France, n.d.[77]).

The Competence Centre could support interactions between stakeholders, by connecting them and providing a platform to share their experiences, best practices and challenges at county level. This could be done by organising trainings, workshops and other events that facilitate knowledge sharing and contribute to raise awareness on NbS. In Hungary, there are municipalities where mayors and politicians are strongly committed to the implementation of green infrastructure (Csizmadia et al., 2022[47]). It is important to encourage the mayors of municipalities with implemented NbS investments to participate in knowledge sharing (Csizmadia et al., 2022[47]). The Competence Centre could promote to share best practices and connect municipalities with experience on NbS and "newcomers", beyond the developed NbS-hub. This could be done at the county branches of the Competence Centre, where the interaction could be fostered between local municipalities. Non-governmental organisations and governmental institutions (e.g. Coordination Office for Municipalities of the Ministry of the Interior), associations such as the public road builders and chambers could provide professional assistance to local authorities through the Competence Centre.

The national Competence Centre could also address NbS procurement. National and/or regional centres for procurement could encourage a more holistic approach to NbS procurement. Establishing a central team collecting the best practices of procuring NbS would inform and advise the implementation process on the best available practices. The Competence Centre could advise the procurement offices on available technologies and specifications that would promote NbS. It could be built on the model of similar organisations, including centres of excellence on procurement include: The Competence Centre for Innovative Procurement (KOINNO) established by the German Federal Ministry for Economic Affairs and Energy. This centre provides consultation and education on innovation-based public procurement. It is an online platform where numerous publications and tools are available to guide public buyers in formulating innovation-driven procurement processes.

3.5. Funding and financing mechanisms

In Hungary, the majority of NbS investments are financed from public budgets and EU funding programmes (EU LIFE, EU Horizon 2020). Private investments could be used as an additional source of funding that relieves the pressure on the public budgets for environmental measures.

To increase private engagement, it is key to understand the benefits that the private sector can obtain from the implementation of NbS. Private actors' willingness to invest increases when their business model depends on natural resources (water utilities, mineral water companies, etc.) and they want to reduce their vulnerability to increasing climate threats. Other drivers can be financial and regulatory tools that the public authorities put in place to incentivise private investment. Corporate environmental responsibility programmes are important motivation for private actors to invest in NbS. These drivers are present in Hungary, but regulatory and financial incentives are needed to channel them into investments for NbS.

3.5.1. Key elements of the enabling environment of Nature-based Solutions funding

There is a long-standing practice on financing grey infrastructure in Hungary, which is based on well-planned mechanisms and knowledge such as reference costs. On the contrary, decision makers are often unaware of the costs and unique characteristics of NbS (because of general low awareness, data shortages, etc.), which must be considered while funding mechanisms are designed.

In Hungary, the majority of NbS investments are financed from public budgets and EU funding programmes (EU LIFE, EU Horizon 2020). Based on the survey results, the respondents identified financial support as the most relevant factor in the uptake of NbS (Prime Minister's Office, 2021[16]). The currently available financial sources that can be used for NbS development are the municipal budgets who are responsible for the implementation, state funds, EU funds, loans and private funds (see Table 3.2.) (Csizmadia et al., 2022[47]).

Table 3.2. Key financial instruments for Nature-based Solutions in Hungary

		Green space	Water sector	Construction	Transport
Municipal budgets	Taxes			Real estate tax	motor vehicle tax
	Fees and charges		Water supply and wastewater treatment fee		parking fee, toll
	Other sources	Urban Development Fund			
State funds	Public funding	Municipal GI maintenance normative support			Applications for construction and maintenance
EU funds	EU direct grants (LIFE, INTERREG)	LIFE, GET	Interreg		Interreg
	Indirect EU grants	KEHOP Plus, TOP Plus	KEHOP Plus, DIMOP Plus, TOP Plus	TOP Plus, KEHOP Plus	TOP Plus
Loans	Loans and bonds Carbon financing	Borrowing, sale of CO^2 quotas	Borrowing	Borrowing, sale of carbon dioxide quotas	Sales of carbon dioxide quotas
Private funds	PPP			Urban Planning Agreement	

Source: (Csizmadia et al., 2022[47])

Significant efforts have already been made to mobilise external funds for NbS projects. For example, Hungarian cities such as Győr and Szeged have been involved in EU programmes such as Horizon 2020

research and innovation programmes and LIFE projects such as Naturvation, Nature4Cities, HungAIRyLIFE and LIFE-MICACC, as well as other projects including LifeTree Check and GREEN SURGE. However, these EU-funded projects are competitive and require certain knowledge and capacities to apply and manage them, which tend to be lacking and represent a challenge for smaller municipalities (Németh, Kravalik and Séra, 2022[75]).

Municipal budgets

Municipalities are the only subnational governments in Hungary that can levy taxes.[10] The main tax levied by municipalities is the local businesses tax, which amounted to more than 80% of municipal tax revenue in 2020. The local business tax is levied on businesses located or registered in the municipality, and the rate is based on gross margins, decided by the municipality, but capped at 2%. Property taxes are the second highest tax received by municipalities, set by each municipality within limits based on the consumer price index, accounting for 17.3% of municipal tax revenue in 2020. They include a building and a land tax, both paid by landowners on area or floor space or on the adjusted market value. However, the tax base does not typically depend on the market value, so revenues remain low despite increases in property prices. Other minor taxes include a vehicle tax, municipal tourist tax, and an environmental protection fee levied on products such as batteries that funds environmental protection activities (OECD/UCLG, 2022[78]; FAOLEX, 2011[79]). With the decrease of municipal revenues in proportion to GDP there is an increase of public sales. In many cases, the sale of land results in the sale of properties that are existing or potential areas providing important ecosystem services in urban areas (Csizmadia et al., 2022[47]). Several cities with county rights have already committed to creating an urban development capital fund as a complementary source of urban development funding to address these challenges (Csizmadia et al., 2022[47]).

State funds

Stage funds are important sources of funding for NbS. They can have several origins: equalisation grants[11], environmental taxes, transfers, and different fees. The 2011 constitutional reform modified the grants system and reduced their amounts, in accordance with the recentralisation of several local government responsibilities. Grants and subsidies amounted to 58.6% of subnational governments' revenue in 2020. A stricter grant system was established in 2013, shifting from an income-based system of block grants, to a task-based, expenditure-oriented system of earmarked grants for each local authority.[12] The reform included the tightening of distribution rules as well as new equalisation criteria based on the tax capacity of each municipality, with the aim of assisting poorer regions, due to striking differences between local governments in terms of local business tax capacity (OECD/UCLG, 2022[78]).

[10] However, since Covid-19 legislation of 2020 (Act LIX), counties are allowed to impose local taxes on "special investment zone". Investment zones are established by government decree in the territory of one or several municipalities if the economic activity within the area is significant and has a relevant effect on the county's economy. The tax imposed by the county replaces the respective tax set at the municipal level. Only one "special investment zone" has been created by decree so far in the area of Göd (government decree 294 of 2020) (OECD/UCLG, 2022[78]).

[11] Government funding that is based on a formula calculated based on average expenditures (different budgetary expenditures for the municipality's operation e.g. wages, maintenance of infrastructure).

[12] Grants are now earmarked, for the majority to current expenditure (62.3% of total grants) and mainly in the fields of education, social protection and culture.

Support for green space management is provided as part of the equalisation grants for the operation of settlements. It should be noted that almost 60 % of actual capital expenditure is also incurred in the equalisation grants (*The HVK Project*, 2018). The fund may be used to construct and maintain green spaces and related structures (Csizmadia et al., 2022[47]).

The allocation of the state funds depends inversely on the size of the settlement. In the case of settlements of less than 2 500 inhabitants, the funding received covers operating costs, and in some cases, there are significant reserves in the system. However, settlements with more than 10 000 people receive less than a fifth of the normative amount, despite the higher demands for green space in larger settlements (Csizmadia et al., 2022[47]).

EU funds

Climate change adaptation and mitigation efforts ranked high on the EU policy agenda in the 2014-2020 period, therefore EU funding programmes have allocated a large amount of funding to these objectives, which in principle provides scope wide-scale application of NbS (Németh, Kravalik and Séra, 2022[75]).

There are three main types of EU funds that are accessible in Hungary to finance NbS-related investments: (1) national operational programmes (OP), (2) European Territorial Cooperation Programmes and (3) directly managed EU funding programmes. The availability of these funding sources has not yet translated into a large number of funded NbS projects (Németh, Kravalik and Séra, 2022[75]).

National operational programmes offer the largest volume of funding for infrastructure investment by municipalities, but their implementation logic favours grey infrastructure solutions and they do not provide incentives for more innovative approaches, including NbS (Németh, Kravalik and Séra, 2022[75]).

European Territorial Cooperation Programmes provide an opportunity for cross-border, transnational or interregional cooperation, capacity building, knowledge sharing, strategy making and pilot actions. Hungarian municipalities are relatively active in these programmes (compared to the number of successful applicants coming from other countries), but there are only a few projects with Hungarian beneficiaries that focus on NbS, suggesting a low level of awareness and interest towards the topic (Németh, Kravalik and Séra, 2022[75]).

Directly managed EU funding programmes highly favour innovative approaches, but they are very competitive and need substantial capacities from applicants to develop a successful proposal. Therefore, only a few, highly committed and ambitious Hungarian municipalities got awarded (Németh, Kravalik and Séra, 2022[75]).

A detailed overview of the available EU funds with a specific overview of the NbS-related elements that can be found in the *Funding Gaps and Opportunities* and *Practical guide for planning and preparation of projects promoting Nature-based Solutions* reports, that has been developed under the framework of the project called “Promoting Nature-based Solutions in municipalities in Hungary” (Németh, Kravalik and Séra, 2022[75]).

Private funds

There are very few examples in Hungary of NbS projects being financed by private stakeholders or using blended financing mechanisms. For example, a company called BorsodChem worked together with the municipality of Kazincbarcika and several other stakeholders to reduce vulnerability to local climate risks through implementing green infrastructure for better rainwater management. Another case used private funding from Audi Hungaria in Győr, where the car manufacturer invested in biodiversity, green infrastructure, and beekeeping to meet corporate goals targeting environment and sustainability (Katona, 2017[80]). In Jászszentlászló, local landowners created an association to retain and manage rainwater to

target drought-related risks. The investments were initially funded by them, but local municipalities also contributed at a later stage.

3.5.2. Financial constraints

The lack of financial resources is perceived as the main barrier to the implementation of NbS in Hungarian municipalities. This is particularly the case in villages and small cities[13], which identified insufficient financial resources as the most important barrier to the implementation of NbS in the survey (Prime Minister's Office, 2021[16]). The share of subnational government expenditure in total government expenditure halved between 2010 and 2020, going from 25% to 12.5%, significantly below the OECD and EU27 averages of 36.6% and 34.3% respectively (OECD/UCLG, 2022[78]). Similarly, the share of subnational government expenditure in public investment went from 59% in 2011 to 27% in 2016, to 20.9% in 2020, well below OECD and EU averages (54.6% and 54.4% respectively). In general, Hungarian SNGs do not play a strong investment role, as direct investment accounted for just 13% of Hungarian subnational government expenditure in 2016.

Current financial allocations to municipalities from the central government often do not cover the full costs of service provision, which consequently limits funds for NbS. Municipalities complement their budgets through local taxes (real estate tax, tourist tax, municipal tax, business tax) and letting and selling their properties and public areas (Csizmadia et al., 2022[47]). According to the size of the local industry and the financial situation of the population, there are significant territorial differences in the tax revenues of local authorities, which is exacerbated by the fact that two-thirds of them are unable to exercise their powers of taxation (Csiki, 2020). This creates significant fiscal capacity asymmetries among municipal budgets.

Currently, there is no funding plan for green investments or NbS in Hungary (Csizmadia et al., 2022[5]). Municipalities currently rely on EU capital funding for NbS implementation, rather than seeking to leverage local taxes, tariffs and fees. There is no financial plan for operation and maintenance of NbS. The main source of revenue for Hungarian subnational government consists of grants and subsidies, which make up 54% of their revenue (compared to 44% for the OECD average), while tax revenues, tariffs and fees make up a smaller share of resources. In addition to levying local taxes, municipalities rent and sell their property (including land and public spaces) to supplement budget allocations, which do not always cover full cost needs (Csizmadia et al., 2022[47]). Similarly to other infrastructure, NbS need funding structures that can help to attract predictable and reliable funding streams from a range of sources. The lack of knowledge on the costs and the lack of instruments, standardised financing models can make NbS unattractive for potential investors (OECD, 2020[17]).

The benefits and co-benefits of NbS (see Section 1.3) are often considered to be public goods rather than private benefits (OECD, 2020[17]). As a result, the benefits of NbS are not yet enough to stimulate private engagement and make the investment into NbS attractive. (Toxopeus and Polzin, 2021[81]).

3.5.3. Main recommendations for funding and financing mechanisms

NbS are still a relatively new approach and not widely spread within Hungary. As with any other type of innovation, public funding, notably EU funding, is playing a crucial role in promoting its uptake. Environment and climate actions are high on the European agenda, and EU funding programmes set ambitious objectives for a Greener Europe. Therefore, in principle, a huge volume of funding is available to implement NbS – but also any other type of climate mitigation or adaptation actions (Németh, Kravalik and Séra, 2022[75]).

[13] Four different settlement sizes are investigated in the survey: villages (population under 10 000); small cities (10 000-50 000; large cities (50 000-300 000), and capital city Budapest.) (Prime Minister's Office, 2021[16]).

However, the financial sustainability of NbS depends on covering operation and maintenance costs from a range of sources, given the constraints on public funding. Therefore, a funding strategy in the short and medium term could be developed including already used EU programmes (LiFE, INTERREG programmes and Horizon Europe), while also seeking to explore new sources of EU funding such as the new common agricultural policy (CAP), new economic instruments to leverage funds from beneficiaries and users. The strategy should also aim to support improved infrastructure maintenance and full cost recovery, where appropriate.

The following sections presents potential options which could be explored to increase the financial sustainability of NbS in Hungary.

Examine CAP eligibility criteria to identify additional funds available for NbS

In December 2021, the new agreement on reform of the Common Agricultural Policy (CAP) was formally adopted. For the period 2023-27, the CAP will be built around ten key objectives. Focused on social, environmental and economic goals, these objectives will be the basis upon which EU countries design their CAP strategic plans (European Commission, 2022[82]). The following objectives are particularly relevant for scaling-up NbS: contributing to climate change mitigation, efficient natural resource management and halting and reversing biodiversity loss.

The new CAP provides a potential source of funding for NbS in the agriculture sector due to its stronger focus on environmental goals. In particular, the new CAP enhanced conditionality linked to environmental elements, being an opportunity to increase NbS use in the sector. Beneficiaries will have their payments linked to a stronger set of mandatory requirements. For example, on every farm at least 3% of arable land will be dedicated to biodiversity and non-productive elements, with a possibility to receive support via eco-schemes to achieve 7%. Wetlands and peatlands will also be protected (European Commission, 2022[82]). In addition, the new CAP introduces eco-schemes, a payment schemes aiming at the protection of environment and climate embedded in the direct payments granted under CAP pillar 1. This could increase funding for NbS because it rewards farmers using nature friendly practices with higher environmental and animal welfare benefits. A new obligation is that Member States must spend at least a certain proportion of their direct payments budget allocations on eco-schemes (the basic rule being 25%), which can fund a wide range of environment- and climate-friendly practices (European Commission, 2022[82]).

The designated body for NbS could collaborate with the Ministry of Environment to identify and promote NbS among farmers, which fit within the Hungarian eco-schemes package. Hungary has proposed a multi-dimensional eco-scheme with multiple commitments, covering all types of agricultural area, aiming to address: biodiversity protection or enhancement, landscape features, non-productive areas, integrated pest management/pesticide management, nutrient management, permanent pastures – maintenance only, soil conservation practices and others issues. Several of these items could be addressed through NbS when combined with a change on agricultural practices (European Commission, 2022[83]).

Secure adequate funding for the implementation and operation of NbS

Municipalities could develop a financial strategy that includes economic instruments, complementing EU funds for NbS. This can be done by the following ways:

Introducing land value capture instruments

Recovering value from public investments also underlies land value capture (LVC) mechanisms. LVC, also known as land value recovery, is one method that enables governments to recover and reinvest land value increases that result from public decisions. By tapping into the windfall profits public investment and urban planning generates in land ownership, it may also avoid the distortions that taxation imposes on economic incentives ((OECD/Lincoln Institute of Land Policy, PKU-Lincoln Institute Center, 2022[84])). It also allows

local governments to raise local funds for cities and communities' urban planning and infrastructure needs (Smolka, 2019[85])).

Many different land value capture tools exist, from taxes, fees or charges to building rights and certificates that can be used to generate revenues to apply to climate-related investments. Different forms of land value capture mechanism exist in most OECD countries, aside from Hungary, as well as Belgium, Ireland, Slovenia and the United Kingdom (Table 3.3). Success factors for land value capture include strong local support, the existence of local technical competences, adequate institutional mechanisms and a commitment from national and local leadership. Cooperation between local and national government (and, potentially, the devolution of some fiscal controls from national to local authorities) is needed to ensure that land value capture is legally feasible before defining the instruments themselves.

Table 3.3. Land value capture (LVC) mechanisms in OECD countries

LVC mechanism	Description	OECD countries in which the instrument is used
Impact fees	A one-time fee required from the land developer to help pay for new public infrastructure and other services, as well as infrastructure to sustain the new construction by the developer	Australia, Austria, Estonia, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Slovak Republic, Sweden, Switzerland, United States
Joint developments	A private public partnership, where public action can be attached to private development, for instance a transit facility, and both parties (private and public) share the costs, revenues, and risks	Austria, Czech Republic, Denmark, Estonia, Finland, Israel, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Slovak Republic, Switzerland, United States
Property tax (only countries that update tax base regularly)[1]	Property or land value taxes automatically capture a share of the increase in property values as long as the assessed property price on which they are based is regularly updated to reflect market values	Australia, Chile, Denmark, Finland, Japan, Korea, Mexico, New Zealand, Portugal, Turkey, United States
Land banking/pre-emptive purchase rights at unimproved valuations	The practice assembling plots of undeveloped or underdeveloped for further development or sale; land banks make profits by reselling land at higher prices than they bought it	Austria, Finland, Germany, Japan, Korea, Norway, Spain, United States
Tax increment financing	An accounting technique through which investments are financed by borrowing against expected increases in future tax revenues	Canada, Finland, France, Korea, Spain, United States
Betterment levy or special assessment	Similar to impact fees, a betterment levy can be charged to capture the increase in property values due to a public action (e.g. rezoning of land or provision of infrastructure)	Israel, Poland, United States
No value capture		Belgium, Hungary, Ireland, Slovenia, United Kingdom

Note: (1) lists only those countries whose property taxes have characteristics that make them effective value capture instruments. Due to the high degree of fiscal decentralisation in federal countries, the availability of any of these instruments may vary significantly from state to state.
Source: (OECD, 2019[86])

Implementing a stormwater fee based on impermeable areas for non-residential zones

A stormwater fee based on impermeable areas for non-residential zones could be developed and implemented to encourage the implementation of NbS at municipal. Multifunctional green infrastructure can reduce the volume and flow rate of stormwater runoff while also removing contaminants from the stormwater (Senes et al., 2021[87]). Non-residential areas can be commercial and industrial properties, parking lots, mixed-use properties, vacant lots, etc. (PWD, n.d.[88]).

Introducing standards on the quantity and quality of the runoff could be a complementary measure to a stormwater fee. Currently, there is no regulator in charge of stormwater management. The General Directorate of Water Management could be well placed to develop the relevant regulation. The regulatory proposal could be prepared in close cooperation with the Ministry of Interior and the Hungarian Energy and Public Utility Regulatory Authority.

There are several international applications of stormwater charges. Many German municipalities have been collecting stormwater fees since the 1980s. The fee is calculated based on the built up from which the water drains into the stormwater sewer system, generating an average fee of EUR 1.31/m^2 (for comparison, Poland charges EUR 0.57/m^2 on average) (Tasca, Assuncaõ and Finotti, 2018[89]). The United States, the Clean Water Act imposes strict standards for the quantity and quality of runoff water. However, the law did not provide a budget allocation to fund the system, therefore, municipalities had to develop their own fees for stormwater. As NbS can be used to reduce the ratio of impermeable areas, decreasing the flow and the concentration of contaminants in the water, the stormwater fee can incentivise their implementation. As illustrated in Box 3.9, the introduction of a stormwater fee in Philadelphia had multiple benefits such as reducing water treatment costs, decreasing flood risk and incentivising NbS.

Box 3.9. Green City, Clean Waters plan, Philadelphia, United States

In 2011, the Philadelphia Water Department developed a 25-year plan, named Green City, Clean Waters plan, to reduce the volume of stormwater entering combined sewers using green infrastructure and to expand stormwater treatment capacity with traditional infrastructure improvements. The intent of the plan is to reduce stormwater pollution of waterways and sewers by as much as 85% within 25 years.

The Department allocated a total of USD 2.4 billion to retrofit about 10 000 impervious acres of public and private land, seeking to green any impermeable surface that channels stormwater into sewers and waterways during precipitation.

In addition to drawing on public spending, Green City, Clean Waters seeks to leverage private investments by establishing a new wastewater pricing mechanism that incentivises owners of non-residential land to finance storm water remediation. The plan sets a charge for stormwater removal services on the basis of impervious surface as a percentage of a property's total size, implying that the landowners' fee for stormwater services decreases with a decline in the impervious surface footprint. Hence, property owners are incentivised to invest in green stormwater infrastructure that costs less than the net present value of the service charge.

Since the implementation of Green City, Clean Waters in 2011, more than 1100 storm water remediation tools have been added to the Philadelphian landscape, by the Philadelphia Water Department as well as by private developers. The stormwater remediation programme is projected to reduce the City's capital expenditure by USD 8 billion in traditional point source investment over 25 years, in addition to ensure the progressive transfer of the cost burden related to stormwater mitigation from the city authorities to private property owners.

The implementation of the programme facilitates the City of Philadelphia's compliance with the US Clean Water Act, as well as produces a financial benefit by shoring up existing bond credit ratings and budget estimates of future debt service costs. The Philadelphia agreement can serve as a model for wastewater infrastructure gap closing measure on national level.

Source: (EFAB, 2014[90]; PW, n.d.[91]; PWD, 2011[92])

Develop a culture of maintenance that considers sustainable management of NbS

A crucial problem for NbS implementation is the rapid decline after the construction due to the lack of maintenance (Csizmadia et al., 2022[5]). The highest performance of NbS is usually achieved months or years after the construction. Therefore, maintenance is crucial for NbS service delivery, like any other infrastructure. Usually, the maintenance of municipal NbS projects will be taken over by the employees of the municipality or enterprises, who often lack the required skills. NbS maintenance companies (e.g. public

green services or water management services) have been underfinanced for decades, forcing municipalities to cut maintenance costs, leading to the fast deterioration of even a well-implemented NbS (Csizmadia et al., 2022[5]).

An underlying issue is that costs are not fully recovered for some services linked to NbS such as water supply and wastewater treatment. For example, many of Hungary's water utilities have carried out EU and government-sponsored investments in the last few years. Because of the financing agreement, the depreciation of these investments must be covered by tariffs. But the future maintenance costs of these recent development projects still have to be included in the price of the services. Moreover, since water and sewerage tariffs were frozen in 2012 and were decreased by law in 2013, revenues collected by utilities are decreasing (World Bank, 2015[93]). Under current practice, operating costs are not recovered.

There is also a need to collect and disseminate data on the costs and maintenance requirements for different types of NbS, noting that this is context specific. For example, establishment, maintenance, and sustainability of NbS is more challenging in areas with shorter growing seasons and harsher weather conditions (The Nature Conservancy, 2019[94]). So far, municipalities considered high maintenance costs of NbS as a main barrier for the implementation as illustrated in Figure 2.4. . Due to the lack of well-documented, long-time experiences with NbS, there is uncertainty on building and maintenance costs[14]. When municipalities carry out a cost-benefit analysis for NbS, they can only refer to the experiences of grey infrastructure projects (Csizmadia et al., 2022[5]).

When planning NbS, the sources of funding should be clarified including operation and maintenance. A regular source of funding should be secured to cover the operation and maintenance costs of NbS. Several options or a combination could be considered: tariffs when the NbS is linked to a service delivery such as wastewater treatment, taxes at municipal level, fees when the NbS is linked to an activity such as a touristic park or national transfers. Alternative revenue streams for operation and maintenance could be explored when designing the project such as CAP (see recommendation on Examine CAP eligibility criteria to identify additional funds available for NbS) and payments for ecosystems services (see Box 3.10).

[14] Especially villages and small cities, who have a small budget, consider the uncertainty of maintenance costs as a major threat (Prime Minister's Office, 2021[16]),

Box 3.10. Payments for ecosystem services to protect groundwater resources in France

The catchment area (impluvium) of the mineral water company Société des Eaux de Volvic (SEV), owned by Danone, covers 3,800 hectares in the old volcanic area of Puy-de-Dôme, in France. The company's mineral water production depends on the availability and quality of groundwater resources, therefore the protection of these water bodies are among their key environmental objectives. There has been no significant groundwater contamination observed yet, but current land use practices can be a potential risk for the quality of mineral water production. In the future, this risk is expected to increase, therefore Danone has put in place actions to protect groundwater resources of its catchment area. One of the key objectives for the company is to protect the quality and stability of the unique mineral content of the water, mostly affected by agricultural and forestry practices. Danone implemented payments for ecosystem services (PES) to improve land-use practices in the catchment area. Farmers and landowners are subsidised to support extensive agricultural practices that are compatible with watershed protection, for example through support for the purchase of equipment.

Source: (IfLS/CCRI, 2017[95])

The following measures that apply specifically to the water sector may complement this good practice (OECD, 2020[96]):

- Consider diversifying revenue streams and tapping into new sources of capital, where needed and in line with policy objectives. A first step could be to combine revenues from water tariffs, transfers from public budgets and transfers from the international community to recover the costs of investment, operation and maintenance of NbS when linked to water and wastewater services as much as possible and where efficient.
- Consider establishing pricing instruments where appropriate and applicable in combination with other instruments (e.g. regulatory, voluntary or other economic instruments), to manage water resources (in particular water conservation), phase out negative externalities (e.g. overuse, pollution), and improve the financial sustainability of water services.

A maintenance culture could be supported by empowering regulatory authorities in charge of infrastructure networks (such as water, transport, wastewater, energy) to collect data on asset conditions and maintenance needs which includes NbS elements. In addition, performance indicators could be set accordingly to ensure that service levels do not deteriorate over time and sufficient funding is assigned to maintenance and replacement activities for NbS (OECD, 2020[96]).

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Annexe A. Nature-based solutions in policies in Hungary

Table A A.1. Nature-based Solutions in related national policies

Theme	Strategies and plans at national level	Content related to Nature-based Solutions
Environmental protection	National Environment Programme (Nemzeti Környezetvédelmi Program - NKP), (NKP-5 is before adoption)	Implicit — Nature-based Solutions in the programme's target system reflect the need for efficient management of natural resources, energy-saving of materials, water, land, land and energy saving
Nature conservation	National Baseline for Nature Conservation (Nemzeti Természetvédelmi Alapterv - NTA) (2014) (The new NTA is expected to be adopted as part of the NKP-5)	Explicit — conservation and development of green infrastructure and mapping and evaluation of ecosystem services
	National Biodiversity Strategy (Nemzeti Biodiverzitás Stratégia – NBS) (2014) (The new strategy is to be adopted)	Explicit — objective of maintaining and restoring landscape diversity, green infrastructure and ecosystem services
Landscape protection	National Landscape Strategy (Nemzeti Tájstratégia) 2017-2026	Explicit — The complex approach provides an example of the complex application of NBS. Its horizontal principles support Nature-based Solutions: (1) the protection of natural resources and cultural heritage in general, (2) wise and sparing land use (3) and climate change mitigation, adaptation
Climate change	National Climate Change Strategy 2 (Nemzeti Éghajlatváltozási Stratégia 2 - NÉS2)	Explicit — although not mentioned by name in the document, it proposes numerous NbS solutions, e.g., afforestation for carbon sequestration; development of near-nature water supply systems
	National Clean Development Strategy 2020-2050 (Nemzeti Tiszta Fejlődési Stratégia)	Explicit — although not named by name in the document, NbS proposes a solution, e.g. afforestation for carbon capture, microclimate improvement of forests
Sustainable development	National Framework Strategy for Sustainable Deveopment (Nemzeti Fenntartható Fejlődési Keretstratégia)	Implicit — The protection and restoration of ecosystem services, including regulatory services related to natural cycles (e.g. climate control, pollination, flood protection) will be given special attention among natural resources.
	National Development 2030 — National Development and Spatial Development Concept (Nemzeti Fejlesztés 2030 – Országos Fejlesztési és Területfejlesztési Koncepció)	Implicit — strategic target level highlights the sustainable use of our natural resources, the preservation of our values and the protection of our environment

Theme	Strategies and plans at national level	Content related to Nature-based Solutions
Water management	Jenő Kvassay Plan (National Water Strategy) (Kvassay Jenő Terv – KJT)	Implicit — objectives include: Water retention to make better use of our waters; Risk-preventive price and waterlogging protection; Improving the relationship between society and water (both individual, economic and decision-making); Renewal of the economic regulatory system for water management
	Flood risk mapping and strategic risk plan - ÁKK	Implicit — according to the Flood Risk Management Concept, general principles that are of paramount importance for NBS planning among the objectives and principles are: Flood safety standards need to be redrafted in order to: 1. Defensive activities against hazards shall be switched to risk management. (2) When exploiting flood-prone areas, it is necessary to adapt to existing hazards. (3) When dealing with floods and waterloggingways, where possible, disaster prevention is a priority over disaster management
	Water Framework Directive/Water Basin Management Plan (VGT3) is pending adoption	Explicit — Measures of paramount importance for NBS solutions include: Ecological mainstreaming in the implementation of sustainable water uses; Measures to promote natural water retentio
	Hungary's irrigation development strategy (Magyarország Öntözésfejlesztési Stratégiája)	Explicit — Among investments in the development of irrigation, aid should prefer to take into account local conditions: to improve water resources and water quality at river basin level, to reduce the impact of agro-ecological extremes and to create harmony between land use and landscape ecology. The implementation of complex melioration (especially soil reservoir) should be supported. Economical and multi-purpose solutions should be supported at the plant level (water retention, reservoir, sewage irrigation, natural wastewater treatment, indoor rainwater management
Water management	Further development of the Vásárhelyi Plan	Explicit — In addition to increasing and amplifying the charge, the excess water at the corresponding sections is to be placed in newly built flood reservoirs along the river under controlled conditions. The planned reservoirs are potential areas of landscape management and NBS. Due to the lack of cooperation between the agricultural support system and farmers, they currently only operate as emergency reservoirs reducing flood peaks
Soil, agriculture, forestry	National Rural Development Strategy	Implicit — its aim is to help prepare for the expected impacts of climate change affecting the basic resources of agriculture and rural development and to create opportunities for adaptation, including the development of water resources
	National Forest Strategy 2016-2030	Explicit — its objectives include the development and application of adaptable forest management alternatives. To promote sustainable forest management, install new forest areas
	Soil Protection Action Plan	Implicit — The aim is to use water- and carbon-friendly, yet degradation reducing tillage technologies. However, erosion reduction and run-off slowdown are not among its action
Transport	National Transport Infrastructure Development Strategy (2030/2050)	Implicit — environmental and climate protection aspects and sustainable management of natural resources are included in its target system
	Environmental Basis for the Sustainable Use of the Danube as a Waterway (2016)	Explicit — specifically analysed in the context of nature and environmental protection

Source: (Csizmadia et al., 2022[47])

Promoting Nature-based Solutions in Municipalities in Hungary

Nature-based solutions (NbS) aim to maintain, enhance and restore ecosystems to address a variety of social, economic and environmental challenges, including climate change and biodiversity loss. This paper applies the OECD's framework to provide recommendations for how to encourage the use of NbS by Hungarian municipalities. It illustrates some of the key challenges in the local implementation of NbS in Hungary and provides international examples of how they are tackled in diverse contexts. It also discusses the role of reforms about the enabling environment to mobilise further public and private investment in climate adaptation.

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