



Biodiversity and Nature-based Solutions

Analysis of EU-funded projects

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Research and
Innovation

Biodiversity and Nature-based Solutions

Analysis of EU-funded projects

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Biodiversity and Nature-based Solutions

Analysis of EU-funded projects

Sandra Naumann and McKenna Davis

Valorisation of NBS projects

The initiative to analyse the impacts of EU-funded projects in the area of NBS and valorise their results in terms of EU added value and policy relevance was initiated in December 2019. Six policy reports and a final consolidated report were produced and can be found at <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>.

The present report aims to provide an overview of results from EU-funded NBS projects and how they support policy implementation in relation to Biodiversity Policy.

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1. POLICY CONTEXT

Healthy and biodiverse ecosystems form the core of Nature-based Solutions (NBS) and the key to success in using them to tackle societal, economic and environmental challenges. These underpinning conditions enable the delivery of critical ecosystem services and improved climate change resilience adapted to locally contextualised challenges (e.g. biodiversity loss, flooding, air pollution and health and wellbeing). To ensure that ecosystems can deliver these benefits to their full potential, it is vital that biodiversity considerations are taken into account in the design and implementation of NBS and not sacrificed in light of other priorities. Such a prioritisation is particularly important given the ongoing deterioration and decline of biodiversity in the EU, as shown by the 'State of nature in the EU' report (EEA, 2020).

The alarmingly low rate of EU species and habitats with a 'good conservation status' (namely 15 % and 27 %, respectively) has also been also recognised by the European Green Deal and the EU Biodiversity Strategy to 2030. As biodiversity is affected by diverse pressures and threats, there is a need to integrate biodiversity considerations in wider sectoral policies, including the Common Agricultural Policy (CAP). Key policies for biodiversity protection are presented in brief below

The **European Green Deal** aims to make Europe the first climate-neutral continent by 2050. While NBS are only directly mentioned in the context of responses to climate change and healthy and resilient seas and oceans, biodiversity is recognised as a key area to contribute to climate neutrality. This is underlined by the Deal's ambition for all EU policies to contribute to the preservation and restoration of Europe's natural capital. The new EU Biodiversity Strategy to 2030 (see below) and 'Farm to Fork' Strategy for a fair, healthy and environmentally-friendly food system will be central in this regard. These and many other promising initiatives as part of the Green Deal have the potential to turn the biodiversity crisis around in Europe and encourage the use of NBS as a tool to do so. In order to achieve the desired impacts and be effective, however, clear objectives, measures, commitment, enforcement mechanisms, adequate financing and monitoring are needed.

Nature-based Solutions to societal challenges are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based Solutions must benefit biodiversity and support the delivery of a range of ecosystem services.

For more information visit the European Commission webpages on Nature-Based Solutions <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>

The **EU Biodiversity Strategy for 2030** is an ambitious strategy that delivers on the EU and Member State commitments as parties to the UN Convention on Biological Diversity. The strategy aims to ensure that ecosystems are healthy, resilient to climate change, rich in biodiversity and deliver the range of services essential to the prosperity and well-being of citizens. Key topics addressed are protected areas, restoration of ecosystems, habitat and species status, urban green spaces, biodiversity to benefit climate and people, new biodiversity governance framework enabling transformative change, and supporting biodiversity through EU external policies. The targets address the main drivers of biodiversity loss and aim to reduce key pressures on nature and ecosystem services in the EU. The Strategy further outlines the ambition to strengthen the biodiversity proofing framework for EU programmes and financing instruments and unlock at least €20 billion a year for spending on nature via e.g. a dedicated natural-capital and circular-economy initiative under Invest EU, the European Green Deal Investment Plan, the EU budget dedicated to climate action, and the mobilisation of further public and private funding at national and EU level. Nature-based Solutions are highlighted as a key instrument for climate adaptation and mitigation and for greening cities. The ambition is high, but also necessary given that the previous EU Biodiversity Strategy to 2020 failed on many accounts (EFH, 2019, Langhout, 2019).

The **EU Birds and Habitats Directives** form the legislative cornerstone of European biodiversity and habitat protection, establishing an extensive network of nature protection areas called the Natura 2000 network. This Network covers 18 % of the EU's terrestrial and 9 % of its marine areas and is considered a core element of Europe's green infrastructure (GI). NBS can contribute to the connectivity of the network and support its management to better achieve conservation goals.

However, efforts to protect biodiversity are not limited to the Nature Directives and EU Biodiversity Strategy. A complex legislative framework of directives, policies, communications and programmes serve to address the range of pressures facing Europe's natural environment. Examples include the EU Regulation on Invasive Alien Species, EU Forest Strategy, EU Water Framework Directive, EU Marine Strategy Framework Directive, the Nature Action Plan, the EU Pollinators Initiative and the MAES (Mapping and Assessment of Ecosystems and their Services) process as well as the **EU Green Infrastructure (GI) Strategy**. This Strategy aims to ensure that the protection, restoration, creation and enhancement of GI in urban, peri-urban and rural areas become an integral part of spatial planning and territorial development to deliver essential services to people and nature.

According to Member State reports collected as part of the Nature Directives (Article 12 and 17), the most frequently reported pressures for habitats and species are from agricultural activities (e.g. abandonment of grasslands and intensification) (EEA, 2020). The **Common Agricultural Policy** is thus of critical importance to biodiversity protection,

having the potential to reduce existing pressures (such as those stemming from direct payments) and make positive contributions through NBS such as the promotion of organic farming or the establishment of multifunctional agro-ecological practices.

Land use and land use changes also play an important role in current policy debates at the EU and global levels, emphasising the need to **better link climate change and biodiversity policies**, including their respective targets and actions. In order to realise these ambitions, NBS are recognised for their potential to contribute to both climate change mitigation and adaptation, while contributing to biodiversity conservation, human wellbeing and other sectoral ambitions. More specifically, NBS can be strongly promoted and upscaled to protect, restore and create ecosystems with a high potential to sequester CO₂, such as wetlands, grasslands, peatlands, and biodiverse forests.

In addition to climate change, ecosystem restoration and biodiversity protection, discussions on the EU's and global biodiversity agendas is drawing attention to nature's contribution and benefits to people and the need to mainstream biodiversity into wider sectoral policies and reduce adverse effects, foster sustainability transition processes, maintain and increase ecosystem health and resilience, and deploy NBS at landscape level. Furthermore, the COVID-19 crisis in 2020 has shown that the destruction of ecosystems and the associated reduction in biodiversity contributes to outbreaks of infectious diseases (Settele et al., 2020). Committed biodiversity conservation at global level is thus an important key to preventing new outbreaks.

2. LINKAGES BETWEEN NBS AND BIODIVERSITY PROTECTION

Tapping the full potential of NBS¹ to contribute to the EU Biodiversity Strategy to 2030 and of the post-2020 global Biodiversity Framework targets requires a dedicated and measurable programme, accompanied by appropriate indicators for assessing the impact and progress.² NBS will play a central role in mainstreaming biodiversity across sectoral policies, as they benefit and are based on biodiversity, while also delivering multiple wider societal, environmental and economic benefits (e.g. human health and well-being, climate change adaptation and mitigation, sustainable urban development). On the other hand, NBS are systemic and will also increase the resilience of increasingly fragile nature reserves threatened by climate change. This multifunctional character also makes NBS a powerful tool to increase much-needed public and private sector investment in biodiversity conservation efforts, even if in many cases biodiversity is viewed as a co-benefit of the NBS rather than the primary objective. Ecosystem restoration will be a key component in delivering NBS for these aims. More specifically, the linkages between **NBS and EU Biodiversity Policies** can be explored in particular via the:

- Implementation of conservation measures by Member States to maintain, sustainably manage or restore natural habitats and wild fauna and flora in the EU territory and more specifically in the Natura 2000 network (as required by the Nature Directives). It is important to note that more traditional conservation measures, such as mowing or grazing grasslands, regular scrub clearance, management of hydrological regimes for wetland areas, would not qualify as NBS as they are more single-objective and aim to benefit species and habitats, while failing to adopt a more systemic approach and deliver multiple benefits.
- Creation of new and restoration of degraded ecosystems as part of the GI network to enhance the delivery of ecosystem services at landscape level, provide healthy habitats for species and improve the connectivity between areas in urban and rural areas throughout Europe.

These actions highlight the importance to protect and restore the existing ecosystems and biodiversity hotspots and to connect them with restored and re-established GI linking to the Natura 2000 Network. Such actions can ensure the coherence and connectivity of the Natura 2000 network and beyond as a means to improve the conservation status of habitats and species. Relevant actions can include forest landscape restoration, floodplain management, river restoration, constructed wetlands or (re)introducing green corridors. A central condition for such interventions should be the maintenance and improvement of biodiversity, while also delivering benefits for other challenges such as climate change, flood protection, air quality and human health and well-being.

¹ The nature-based solution concept builds on and supports other closely related concepts, such as the ecosystem approach, ecosystem services, ecosystem-based adaptation/mitigation and green and blue infrastructure, which is illustrated by the findings from other sections of this project review. In this context, projects often refer to those similar concepts and not NBS exclusively.

² The NBS Task Force N°2 (coordinated by EASME and DG RTD) works on developing common indicators to monitor and evaluate the impacts of NBS interventions within H2020 NBS projects and beyond, as a framework for more streamlined data collection and evaluation.



Figure 1. L: River restoration for flood protection in Grimma, Germany, NATURVATION © Sandra Naumann; R: Woluwe Park pond, part of Brussels green network, Belgium © Linda De Volder, Flickr (CC BY-NC-ND 2.0)

NBS are also essential to enable **sustainable agriculture production systems**. Nature-based farming practices are available that provide win-win scenarios, i.e. simultaneously addressing climate change mitigation and adaptation, biodiversity protection, soil and water management objectives. In the majority of cases, these also make long-term financial sense for farmers (improved resource efficiency and resilience to climate impacts), but there are short-term costs and risks that need to be overcome. Promoting NBS in rural areas requires a three-fold approach:

- broad application of agro-ecological agronomic practices - examples include cover/catch crops and reducing bare fallow, retaining crop residues on the field, extending perennial phase of crop rotations, using perennial crops (also for alternative protein production), permaculture, using adapted crops, reduced tillage and zero tillage;
- promotion of agroforestry, woody landscape features or food forests, which can be part of a GI network and qualify as NBS given their multifunctionality; and
- enhancing agrobiodiversity for resilient farming systems, healthier nutrition and human well-being - this would encompass both nutritionally-rich biodiversity (cultivated and wild edible species) and 'functional agrobiodiversity'.³

In addition, **urban areas** have substantial potential to contribute to biodiversity protection by implementing biodiversity rich NBS (urban allotments and gardens, green parks, pollinator sites, green corridors, restored wetland, sustainable urban drainage systems or green roofs). These NBS interventions can bring additional and more diverse nature into cities, playing a critical role in improving human well-being and health, increasing social cohesion, raising knowledge and awareness, and re-connecting people with nature in highly populated and built areas.

³ Functional agrobiodiversity (FAB) refers to 'those elements of biodiversity on the scale of agricultural fields or landscapes, which provide ecosystem services that support sustainable agricultural production and can also deliver benefits to the regional and global environment and the public at large' (ELN-FAB, 2012).

To conclude, **biodiversity-driven NBS interventions** embrace nature protection and sustainable management measures, but go beyond these to deliver multiple benefits (e.g. for recreation, human health, climate change mitigation or food production) alongside contributions to species and habitat protection. By deploying systemic thinking, NBS should be used in ways which employ an understanding of the structure and functioning of local ecosystems and wider landscapes as well as factors that can influence these systems over time, to address a broad scope of societal challenges. As such, biodiverse NBS are highly adaptable to effectively respond to changing local conditions and are often more cost and resource efficient than purely technological approaches (EC, 2015).

3. THE EVIDENCE BASE

3.1 THE ROLE OF NBS TO SUPPORT BIODIVERSITY POLICY OBJECTIVES

Several EU-funded projects have identified types of NBS that offer particularly high benefits for biodiversity (see Table 1). A few of the demonstration projects focus specifically on achieving and measuring these impacts on biodiversity. Relevant NBS include those aiming to improve ecological conditions, stop biodiversity loss, protect valuable ecosystems and landscape, enhance the delivery of a range of ecosystem services, improve functional and structural connectivity, create natural areas and/or benefit the Natura 2000 network in (peri-) urban and rural areas through locally adapted, resource-efficient and systemic interventions.

TABLE 1. Types of NBS created and/or evaluated in research projects⁴ with expected benefits for biodiversity

<ul style="list-style-type: none"> • Renaturing landfill sites, brownfields and river corridors • Restoration of catchments and coastal landscapes • Green roofs and walls • Cycle and pedestrian green route • Arboreal interventions (shade and cooling trees, planting and renewal urban trees) • Resting areas (green spaces projected for resting, relaxation, observing nature, social contact) 	<ul style="list-style-type: none"> • Community-based urban farming and gardening • Connecting green and blue areas, • Pollinator sites (verges and spaces, vertical/walls, roofs, modules) • Sustainable urban drainage system with plants providing habitats for insects and thereby birdlife, amphibians and/or native plants), • Urban rooftops combined with photovoltaic systems
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Assessment frameworks designed to monitor the impacts of new or existing NBS typically contain indicators on biodiversity and green space management. Biodiversity indicators can include, for example: the relative proportion of natural areas, structural and functional connectivity, number of native bird species within urban GI, or a change in numbers of native species. A combination of spatial data and on-site surveys can be used to gather these biodiversity data (e.g. bees and butterflies) both within and in the proximity of a specific NBS. Indicators for green space management can focus on the distribution of public green space, accessibility of urban green areas, and ambient pollen concentration.

However, there are only a few examples of projects assessing the impact on biodiversity in greater detail. Exceptions include RECONNECT and TURaS. Preliminary monitoring results from NBS implemented in RECONNECT for example, show positive effects on biodiversity such as increased biodiversity, re-introduction of rare species and higher perceived naturalness (Penchev et al. 2019).

⁴ These include RECONNECT, ProGReg, TURaS, URBAN GreenUP, Urban Allotment, GrowGreen, PHUSICOS, UNaLAB, NATURVATION and several LIFE projects (e.g. Scallium, Green4Grey).

The TURaS project analysed the “Barking Riverside - brownfield landscaping” case study as an example of biodiversity-focused urban GI. The project demonstrated that the mosaic of habitats created within the landscaping have enhanced site biodiversity, recording 148 species of higher plants on just 0.5 ha of urban landscape; significantly greater floral diversity on brownfield landscaping areas than on surrounding soft landscaped areas were also identified (Connop et al., 2016). The authors concluded that such biodiverse GI can play a vital role in urban conservation efforts if incorporated at a landscape-scale (Connop et al., 2011; 2016).



Figure 2. Ephemeral wetland roofs and Bombardier Beetle (*Brachinus sclopeta*) at Barking Riverside © Stuart Connop

Ecosystem restoration and management

Research projects and LIFE-funded demonstrators (i.e. Green4Grey, Scalluvia) conducted assessments, analyses and habitat enhancement activities to generate new knowledge on ecosystem restoration and connectivity. Significant progress has been made to map and assess the state of ecosystems and their services in their national territory in the EU and involving policy and stakeholder in this process (ESMERALDA, Maes, 2016, Maes et al., 2018).

Moreover, projects such as MERCES and AQUACROSS have produced degraded habitat maps and identified ecosystem attributes (e.g. species composition,

structural diversity and ecosystem functionality) and illustrated how these relate to the restoration potential in marine areas. This work provides a basis for the efficient restoration of marine and other habitats (Bekkby et al., 2017). The OpenNESS project developed a framework to identify priority areas for GI and its restoration across the EU Member States. Three scenarios were developed to reflect the multifunctionality of GI ecosystem service provisioning, and biodiversity conservation, and thus their simultaneous contribution to multiple policy objectives (Vallecillo et al., 2016: 8).

TABLE 2. Scenarios to identify priority areas for GI (OpenNESS)

1. **Nature for Nature (N4N):** this scenario aims to identify multi-functional areas based solely on the supply of ecosystem services and the land use suitability for threatened and vulnerable species. It is based on the principle of GI aiming at 'protecting and enhancing nature and natural processes'
2. **Nature for People (N4P):** this scenario aims to identify GI that would primarily enhance natural processes but also contribute to human well-being in a more direct way, so that a higher number of people may benefit from ecosystem services. Therefore areas closer to populated places are preferentially selected.
3. **Nature to Restore (N4R):** this scenario prioritises multi-functional areas that are preferentially under poor ecosystem condition. The selected areas, therefore, would be closely related to socio-economic systems where drivers of change might compromise the multi-functionality in the long run.

A comparative assessment of these scenarios, building on spatial data, showed that GI could be efficiently established close to densely populated areas. Restoration costs in these areas are typically higher given the poor ecosystem condition resulting from degradation, but investment in those places was found the most cost-effective if human beneficiaries were accounted for in the assessment (Vallecillo et al., 2016: 11). This prioritisation framework has been taken up and further developed by JRC (Estreguil et al., 2019) to provide methodological guidance to support strategic policy and decision-making on GI from the local to the EU level.

Projects also investigated ecosystem-based management approaches and adaptive management to manage ecosystems in a sustainable and integrated manner, and to measure the contributions to meeting EU biodiversity goals. As revealed by AQUACROSS (2016), ecosystem-based management can - by identifying the links between economic, social, and environmental goals - help identify trade-offs and pinpoint win-win synergies for biodiversity and human well-being. Such systemic and integrated approaches can be valuable to manage the inherently multi-sectoral, transboundary and spatial nature of biodiversity.

Other projects have also provided valuable forms of support for designing and implementing biodiverse NBS, such as: guidance to jointly assess biodiversity, ecosystem functions and ecosystem services in a qualitative or quantitative way (Domisch et al., 2017, AQUACROSS); tools to systematically integrate local knowledge and practices into formal environmental assessments and decision-making processes and support adaptive management approaches (Sharp et al., 2011, TESS, 2011); and insights on the correlation of different land use intensities and the status of biodiversity and ecosystem service delivery (Vallecillo et al., 2016, OpenNESS).

Urban biodiversity

With a growing focus of H2020 NBS projects on cities, research and evidence on urban biodiversity is also increasing. An analysis of the 976 NBS cases in NATURVATION's [Urban Nature Atlas](#) revealed that the most frequently reported challenges addressed (circa 85 % of the NBS) were the creation of green space and protection of biodiversity and habitats (Almassy et al., 2018). Yet only a third of NBS included in the Atlas have explicit biodiversity goals and actions. A more detailed analysis of these cases (Xie and Bulkeley, 2020) shows that many cities are already actively engaged in NBS with different types of biodiversity actions to conserve and restore nature (focusing more heavily on conservation) and mobilise people's ability to thrive with nature. Restoration was given higher priority (70 % of projects) in urban rivers, streams, and estuaries, and lower priority (17 %) in community gardens. Moreover, circa 43 % of NBS in large urban parks and forests have restoration goals and actions.



Figure 3. L: Living Classrooms Thrive at Meadowood Special Recreation Management Area © Jennifer Stratton on Flickr (CC BY 2.0); R: Pollinators at botanical garden © Lorna Winship, NATURVATION

Allotment gardens are studied in several projects as important urban green space features, providing e.g. food production, local climate regulation and air quality, aesthetic value of landscapes, pollination, and a location for socialising. Such gardens also host high plant species richness and diversity, including species of EU importance (Speak et al., 2015, Borysiak, 2016).

Research findings from the Urban Allotment Gardens project shows that deploying NBS or sustainable practices such as permaculture can boost biodiversity, but that local policy support is needed to promote urban biodiversity via education, social media or targeted planning processes. Accordingly, guidance and recommendations to foster and manage biodiversity-friendly urban gardens have been prepared for policy makers and gardeners (Jokinen et al., 2016).

TABLE 3. Enhancing measures for urban biodiversity

To enhance urban biodiversity and targeted GI planning and implementation, ESMERALDA identifies the following needs (Balzan 2017: 7):

1. Develop our understanding of biodiversity patterns in the city,
2. Soften the landscape to increase urban GI and biodiversity, and ecosystem service delivery, and
3. Support the notion that targeted GI planning contributes significantly to the creation of future liveable cities that support biodiversity and human well-being.

Agrobiodiversity

Different policies reflect the importance of ensuring the contribution of agriculture and forestry to maintaining and enhancing biodiversity by managing them in a sustainable way (e.g. Target 3 of the EU Biodiversity Strategy 2020, Aichi-Target 7, SDG 2). This is very important as the most frequently reported pressures for both habitats and species stem from agricultural activities, followed by urbanisation (EEA 2020). The implementation of resilient agro-ecological practices as part of more efficient and sustainable food production systems can i) improve the ecological status of habitats, ii) increase biodiversity, and iii) help to strengthen capacity for climate change adaptation, not least through a progressive improvement of land and soil quality (CBD, 2019; Zwartkruis et al., 2015). There was little evidence on agrobiodiversity and the link to NBS (such as agro-ecological practices) in the reviewed research projects, but several LIFE projects made a significant contribution to increase biodiversity in (intensively) used farmland. This included restoring such farmland to valuable semi-natural habitats, agri-environmental measures to restore feeding and resting areas for specific bird species, biodiversity-friendly agricultural practices, or measures to reduce the impact of intensive agriculture on nearby nature areas. A few project examples which were implemented in Natura 2000 sites are presented in Table 4.

TABLE 4. LIFE projects which increased/will increase farmland biodiversity

<p>Dommeldal: Transboundary habitat restoration in the valley of the Dommel, NL/BE (link)</p>	<p>Transboundary restoration of heathland and wet forest biodiversity, establishing an ecological corridor and fostering extensive grazing.</p> <p>Benefits: increased quality of priority habitats (fens and alluvial forests), expanded habitats of breeding and other reed-inhabiting birds.</p>
<p>BioDiVine: Demonstrating functional biodiversity in viticulture landscapes, FR/ES/PT (link)</p>	<p>Implementing biodiversity-friendly practices on vineyards, i.e. use of inter-row ground cover, planting hedges, building or restoring traditional low walls, or allocating non-productive areas.</p> <p>Benefits: Enhanced quantity and quality of semi-natural features, improvement of arthropods, soil micro-organisms, birds, mammals, and plants.</p>
<p>AYBOTCON: Conservation of <i>Botaurus stellaris</i> and <i>Aythya nyroca</i> in SPA Medzibodrozie, SK (link)</p>	<p>Restoration and management of around 280 ha of water biotopes, creation of buffer zones (green zones) around wetlands on arable land to reduce agricultural pollution and eutrophication.</p> <p>Benefits: Increase of Bitterns and Ferruginous duck population and restored wetland ecosystems and functions.</p>

Recent pilot-scale initiatives such as the Biodiversity for Food and Nutrition project ([BFN](#)) have demonstrated the value and additional benefits of underutilised nutrient-rich biodiversity by using innovative research partnerships and approaches to increase the knowledge, appreciation, awareness and utilisation of this diversity, encompassing both cultivated and wild edible species. These innovations and approaches are designed to meet the challenges of environmental sustainability, improved diet-related health and nutrition and betterment of livelihoods in the 2030 sustainable development context as well as contributing to biodiversity conservation (CBD, 2019:4).

Ecosystem resilience

There is little research on the extent to which biodiversity and related NBS contribute to healthy ecosystems and to building resilience. The TURaS project is one of the few

projects, highlighting the potential of incorporating locally contextualised biodiversity-led urban GI design into the planning and policy spheres as a means to foster urban resilience (Collier, 2016). More commonly, projects instead focus on the conditions and factors to enhance urban resilience and increased adaptive capacity of cities without a specific focus on the role of biodiversity in this context (e.g. in OpenNESS and ENABLE).

3.2 CONTRIBUTION OF BIODIVERSE NBS TO CLIMATE AND OTHER POLICY OBJECTIVES

NBS are increasingly recognised for their potential to contribute to a diversity of societal challenges, not least climate change mitigation and adaptation⁵. Carbon-rich ecosystems such as biodiverse forests, grasslands, peatlands and wetlands play a key role in sequestering carbon and supporting EU and global climate goals. These and other natural habitats across the EU are largely assessed by Member States as being in bad condition and/or needing to be restored or managed more sustainably.

The Stockholm Environment Institute estimated that on a global scale, extensive ecosystems restoration could provide 220–330 Gt of carbon dioxide removal (Kartha and Dooley, 2016). The importance of biodiversity and ecosystem restoration to achieve climate targets is not only emphasised in the new EU Biodiversity Strategy to 2030, but is also acknowledged by some European climate plans, demonstrating the benefits of such actions. Examples include seagrass meadow restoration in Portugal or the advice from the UK Natural Capital Committee⁶ to prioritise NBS interventions, such as maintaining and increasing tree cover, peatland restoration or improving wildlife and biodiversity for 2050 climate neutrality.

While the contributions to climate objectives were explored across several projects, the explicit consideration of linkages and causalities with biodiversity in this context is limited. Positive **relationships between biodiversity and ecosystem service** (ES) delivery are widely implied and assumed within both the scientific and policy literatures, but empirical evidence is limited supporting these relationships (Filazzola et al., 2019, Schwarz et al., 2017).

The majority of reviewed projects instead consider biodiversity as one of several (co-) benefits of NBS and assume that implementing NBS will automatically improve both biodiversity and the delivery of ES, thereby contributing to diverse sectoral policy objectives. The role of particular species and specific functional traits are understudied. Schwarz et al. (2017) suggest that as urban planners are increasingly considering ecosystem service delivery in their decision-making processes, researchers need to address these substantial knowledge gaps to allow for the adequate accounting of potential trade-offs and synergies between biodiversity conservation and the promotion of ecosystem services.

⁵ More information on these and other topics can be found in other sections of this project review.

⁶ Natural Capital Committee (2020) [Advice on using nature based interventions to reach net zero greenhouse gas emissions by 2050](#).

ENABLE was one of few projects to explicitly consider biodiversity as a factor in the delivery of ES from NBS. Within this project, Naumann et al. (2018) conducted a literature review which highlighted that only limited studies have explored the linkages between biodiversity attributes (species abundance, species diversity, and community habitat structure and species richness) and the delivery of cultural ecosystem services (e.g. landscape aesthetics and recreation). These are often linked only to taxonomic biodiversity metrics (species richness and diversity) rather than functional biodiversity metrics (e.g. habitat structure). URBES also produced a factsheet on biodiversity and human physical and psychological health and well-being (URBES, 2012), but this guidance only refers to ‘trees’ and ‘nature’ more broadly when outlining sectoral contributions.

TABLE 5. Measuring the contribution and value of biodiverse NBS

While several projects aimed to increase the evidence surrounding NBS contributions to climate and other objectives, the explicit consideration of biodiversity’s contributions is limited. The following tools try to address this gap:

- **NAIAD’s Co\$tingNature tool** links biodiversity and climate change; by analysing biophysical co-benefits of natural capital, it indicates the overall conservation priority of areas that provide flood storage services, but which are not already protected; the tool can be used as a basis for targeting NBS at the EU level.
- **TreeCheck App** quantifies the contribution of specific types of plants to city climates, amongst other functions.

Tapping the full potential of biodiverse NBS to contribute to diverse sectoral targets necessitates a **mainstreaming into existing policy frameworks** outside of the green/environmental niche, rather than being treated as an isolated programme. In NATURVATION, Davis et al. (2018) reviewed and assessed the current type and degree of EU policy support for NBS, finding that significant room remains for increasing cross-sectoral integration of NBS and for considering biodiversity therein. Breaking silos remains a key challenge in this regard as well as increasing the knowledge and evidence base as a means to foster wider support and awareness of biodiverse NBS as a multifunctional approach to address societal challenges.

Accordingly, the need to increase awareness about these benefits is also critical to increasing the implementation and impact of biodiverse NBS (URBANGAIA, n.d.). Increasing recognition of the potential returns on investments in wetlands, urban forests and parks, green walls and roofs, and green corridors will in turn help promote and prioritise urban green space development and ecological restoration (URBES, 2014), as well as other biodiversity-friendly solutions e.g. composting, bee friendly cities, eco-friendly food production, eco-friendly gardening and lifestyles, nature conservation and management and nature education (Berry, 2018).

3.3 CONSIDERATION OF NATURE-PEOPLE INTERACTIONS

NBS are associated with a range of benefits alongside biodiversity protection which are generated from the delivery of ecosystem services. These include, for example, climate adaptation and improved attractiveness for investors (Gill et al., 2007, Kabisch et al., 2016, Wild et al., 2017). However, societal benefits arising from the delivery of cultural ecosystem services, such as reducing mental stress or fostering a sense of community, have been historically far less prevalent in NBS discourse. These considerations have been addressed by fewer research projects.

Biocultural diversity as a novel concept to assess the interrelatedness between people and their natural environment was studied in depth by GREEN SURGE as a response to challenges such as the loss of biodiversity and degradation of ecosystems in urban areas, and the loss of peoples' interaction with nature. This concept takes local values and the practices of different cultural groups relating to biodiversity as a starting point for creating solutions which support a sustainable coexistence between people and nature. Such knowledge is important to facilitate nature conservation and stewardship in cities and other populated areas (Elands et al., 2019). The ENABLE project, for example, adopts a wider perspective than the traditional ecosystem services approach to explore a diversity of cultural ecosystem services provided by urban ecosystems and biodiversity. These take into account relational values describing the human-environment relationship and further benefits, such as place attachment, identity, social belonging (Naumann et al., 2018).





Figure 4. Community garden in Bogotá and urban garden in London © Ewa Iwaszuk;
Urban gardens to support environmental education © Shutterstock

The concept ‘Nature’s Contributions to People’ (NCP), driven by IPBES (2017), builds on the ecosystem services concept to encompass ‘contributions, both positive and negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people’s quality of life’. Literature on NCP emphasises the concept’s ability to capture a range of worldviews, knowledge systems, and stakeholders (Kadykalo et al., 2019). In order to realise the potential of nature’s contribution to people but also peoples’ impact on nature, BIOMOT emphasises that a shift is needed in biodiversity policies to close the gap between intended and real policy actions. To this end, the project has designed a theory of committed action for nature to help society to act more effectively (BIOMOT, 2015). This framework involves building objectives, policies, programs and practices expressing the eudemonic values of nature (i.e. values of connectedness with nature that create meaningfulness in the lives of people, communities and nations). Most saliently, committed action for nature is fostered by people feeling connected with nature as part of a meaningful life.

3.4 COLLABORATIVE APPROACHES FOR BIODIVERSE NBS

The importance of stakeholders as knowledge-providers and contributors and thus the need to support wider participation in NBS-related activities is highlighted by numerous projects and supported with the development of e.g. co-creation guidelines (see e.g. CLEVER Cities’ online co-creation guidance tool, which can be applied across different themes). Rarer, however is research focusing specifically on engagement with biodiversity

and the added value that can be achieved through increased participation in biodiversity conservation or monitoring ambitions.

Projects working in this area focus largely on how to foster collaboration and involve stakeholders in inclusive planning and decision-making processes in order to take user needs, preferences and requirements into account. Such 'co-creation' processes enable the development of functional, effective and accepted interventions responding to local needs and also foster knowledge exchange, align stakeholder expectations and help build trust (see Table 6 for more examples).

TABLE 6. Evidence and tools for co-monitoring, mapping and data sharing

Several projects highlight the need for the co-production of knowledge on urban biodiversity and ecosystem services using transdisciplinary approaches:

- 'Ecology for the city': transdisciplinary paradigm to co-produce knowledge about urban ecosystems and their services and identify solutions for improved adaptation and urban resilience (ESMERALDA, Balzan, 2017)
- Use of training and mapping workshops for policy-makers and scientists to collaborate to deliver products based on reliable data and scientific expertise and enhance uptake of scientific outcomes in policy (Maes, 2016)
- Collaboration and co-creation of knowledge across multiple scales and sectors with city officials to introduce a systemic understanding of NBS (EnRoute; OpenNESS; BiodiverCities⁷)

Tools developed to foster participatory biodiversity monitoring include:

- [Tree Check app](#): engages the public in urban greenery care in a fun way, by offering the opportunity to help cool down cities by measuring tree cooling and monitoring their condition.
- [MapNat app \(URBANGAIA\)](#): enables mapping of the use of nature's services in locations where they are being used, providing access to other users' records; citizens can map or search for e.g. bird watching spots and report environmental issues such as bad water quality, pests, or plants causing allergies or hay fever.

PEGASUS case study research has shown how careful investment in more socially ambitious processes can generate long-term gains with important legacy impacts, fostering resilience among communities of shared interest to manage future challenges and uncertainties (PEGASUS, 2016). In order to do so, however, requires tailored approaches to (1) measure preferences for biodiversity and NBS, (2) take preferences into account in planning processes and (3) maintain ongoing engagement (where desired) throughout the NBS lifespan (Naumann et al., 2018).

⁷ [BiodiverCities](#) is funded by a grant of the European Parliament and implemented by the Joint Research Centre and DG Environment. It aims to deliver a roadmap to enhance biodiversity and green infrastructure in European cities by 2030.

AQUACROSS highlights that in order for ecosystem-based management (EBM) to be operational and benefit biodiversity, a level of common understanding and consensus is needed between scientists, policy-makers and stakeholders on the status of aquatic ecosystems and means to improve this. The AQUACROSS project supports the institutional processes (including decision-making) by conveying scientific knowledge and integrating stakeholders' perceptions and information to help establish the problem (through an assessment of the baseline scenario) and the design of comprehensive societal responses involving EBM management and policy scenarios (Piet et al., 2017). PHUSICOS underlines this finding, citing NBS co-design and innovative participatory processes to be a key governance enabler for successful implementation and long-term acceptance and impact.

3.5 ROLE OF NBS TO SUPPORT SUSTAINABLE TRANSITION PROCESSES

The topics of sustainable transition and transformation have been addressed by certain research projects from different perspectives, but the link to NBS and particularly biodiversity is not always elaborated.

Transformation of the biodiversity agenda

Developing and implementing integrative and holistic management approaches is a prerequisite for transition processes towards a more sustainable society. In this respect, different approaches for ecosystem restoration have been studied and tested by different research projects and are presented in Table 7.

TABLE 7. Integrative and holistic management approaches for restoration

Ecosystem-based management is an adaptive and sustainable ecosystem management approach considering ecological integrity, biodiversity, resilience and ecosystem services to enable the delivery of multiple benefits for human well-being and wider societal and policy goals (AQUACROSS, 2016).

Assessment frameworks should also consider physical processes and temporal and spatial aspects going beyond river restoration project boundaries and project life spans. In addition, well-defined quantitative success criteria, the application of existing planning and management tools and the adoption of a synergistic approach with other resource users are key (REFORM, Kampa & Buijse, 2015).

An integrated valuation framework, which takes account for the plural values of biodiversity and ecosystems should be used to ensure that social-cultural values are adequately considered in ecosystem management and restoration. A range of novel and innovative methods have become available to assess those values (ESMERALDA, Maes et al., 2018).

Several projects emphasised the potential of policy to foster transition, through improved implementation of existing (EU) legislation, increased mainstreaming of biodiversity across policies, better adaptation of policies to local needs, and an ‘uncoupling’ of growth and resource use (Rouillard et al., 2017). In addition, policies should be designed to: support empowerment and innovation (e.g. focus on outcomes and results; encourage engagement in management); focus on capacity building, facilitation and multi-actor engagement; encourage more cooperation and collective approaches; and foster local governance (Maréchal et al., 2018).

The PATHWAYS project examined selected niche-innovations that combine land uses functions (e.g. agro-food production, nature management, water management) and collaborate with other actors or participate in different actions simultaneously (e.g. protecting against floods and creating nature). Pathways aimed at achieving more efficient land use and were assessed regarding their impact on biodiversity (Zwartkruis et al., 2015, see Table 7).

TABLE 8. Niche innovation and pathways analysed in PATHWAYS

1. Biodiversity in cities (urban farming)
2. Business and biodiversity
3. Local renewable energy production (Renewable energy production in agricultural systems (e.g. biogas, using by-products for energy production) solar/wind farms)
4. Resilient landscapes for ecological protection (Room for the river)
5. High nature value farmlands (Agricultural nature conservation: Agri-environmental schemes)
6. Natural heritage landscape (Tourism/ recreation in nature areas)

Pathway A:

- Technologies and need for more societal acceptance moving from intensive to extensive land use due to increase productivity and rewildering (2015-2030)
- From CAP to innovation policy (2030-2050)

Pathway B:

Changing consumption, perception and moving towards ecological intensification (2015-2030) – Broader regime transformation

Results show that both pathways imply relatively challenging transitions at many levels (e.g. societal, economic, technological). Total levels of biodiversity will increase in all scenarios of land use; higher values of biodiversity can be expected for Pathway B, as agricultural abandonment leads to an increase in natural habitat.

Both pathways were found to require substantial reorientations of current trajectories (including policy support), but changes are only occurring slowly. The niche innovations that are likely to be able to break through in the short term are business and biodiversity. This reflects the need for alternative ways to finance nature and for an increased awareness amongst businesses of sustainability issues and the importance of biodiversity. Overall, the project concluded that transitions can be enabled if relevant actors change their commitments, strategies, investments and behaviours (Zwartkuis et al., 2016).



Figure 5. Sustainable farming landscape © Christian Heitz on Pexels

Necessary conditions for fostering transitions towards sustainability through NBS

The ARTS project highlights that engaging in NBS is a powerful way for transition initiatives and governments to address environmental challenges and bring about transformative societal change. This highlights the importance of local actors, who can spark social innovation and accelerate sustainability transitions by bringing together governments, citizens and nature in the design and implementation of NBS (ARTS, 2016).

Focusing in particular on the contribution of NBS to sustainability transition processes, the following three findings are crucial: (1) collaboration is critical for change; (2) government bodies need cross-cutting interfaces and agile structures; and (3) change requires long-term investment. Such transitions require the use of new models of participation and collaboration across sectors and scales, new models for progressive social interaction, and paradigm shifts illustrating the potential of NBS by as a powerful tool to promote social and natural regeneration, re-connection, and collective-value creation (ARTS, 2016).

4. NBS GOVERNANCE TO DELIVER BIODIVERSITY BENEFITS

While numerous projects outlined potential governance models for NBS and key enablers for successful NBS planning, implementation, monitoring and maintenance, the large majority of findings do not draw explicit links to biodiversity. The findings are thus equally applicable to NBS for climate mitigation or adaptation, human well-being or biodiversity conservation, and even for sustainable approaches in general. Nevertheless, key findings in this area are summarised below.

TABLE 9. Key governance enablers of successful NBS

- Fit-for-purpose polycentric governance, i.e. novel arrangements in the public administration involving multiple institutional scales and/or actors
- Financial incentives for community-based implementation and monitoring of NBS
- Integrated planning approaches
- Binding regulatory mechanisms, such as standards on green space availability
- Quantified, measurable targets relating to NBS deployment
- Political commitment at the national and city levels
- Targeted investments and financing (not least for providing advice, facilitation, cooperation, and capacity building to strengthen institutional capacities, knowledge and expertise)
- Collaborative planning and decision-making approaches, integrating a diversity of stakeholders
- Environmental advocacy coalition groups, along with individual champions to advocate for NBS
- Building of sufficient social capital and trust between actors

Regarding biodiversity specifically, the TURas project (Collier, 2016) looked at the rehabilitation of damaged urban ecosystem services to boost urban biodiversity. They found that the creation of visions, feasible strategies, spatial scenarios and guidance tools to enable adaptive governance, collaborative decision-making, and behavioural change for more resilience, are central to achieving desired impact. The project also outlines the value of incorporating locally contextualised biodiversity-led urban green infrastructure (GI) design into the planning and policy spheres in order to ensure the functioning and resilience of the city and provide the adaptability to respond to locally contextualised challenges (e.g. flooding, air pollution, biodiversity loss).

GREEN SURGE also highlighted the value of considering biodiversity in urban GI planning and governance, particularly as relates to user preferences and the delivery of specific benefits. The project accordingly takes biodiversity and the biophysical structures of urban GI into account as well as user group diversity, and neighbourhood cultural and economic characteristics during the planning process. This application in the context of Western urban societies presents an innovative and novel approach and requires further operationalisation in urban GI planning and governance (Vierikko et al., 2015; 2017).

The need to account for local considerations is underlined by AQUACROSS (Piet et al., 2017), emphasising the identification, screening, and design of social and institutional conditions to enhance the governance in ecosystem-based management and contributions to achieving societal goals relating to biodiversity. Kenward et al. (2011) from the TESS project also confirm the benefits of adaptive management and add the importance of the role of leadership for the provision of ES. The project provides evidence from empirically justified governance strategies that are capable of improving the management of human-altered environments, with benefits for both biodiversity and people.

BESAFE (2015) looked to improve biodiversity policy making and governance at various scales. The project found that a top-down policy framework setting goals for the protection of particular sites and species is important, but that an integrated approach seeking to mainstream biodiversity concerns across all policy sectors and including biodiversity outside protected areas what is really needed. This requires the cooperation and active engagement of all relevant stakeholders and investments by authorities to initiate, facilitate, monitor, guide and encourage collaborative decision-making processes and actively support an adaptive management approach wherever possible. This was also underlined by PHUSICOS, which draws attention to the value of policycentric governance as an enabler for successful NBS.

BOX 1. Isar River Basin case study: polycentric governance in action

Within the PHUSICOS project (2019), the Isar-Plan case study (Munich, Germany) successfully deployed a polycentric governance approach to restore an 8 km long river section as a NBS to increase flood protection, recreational potential and improve ecological quality. This required the regional and municipal water authorities to collaborate to advocate a far broader vision for the Isar than their customary focus on grey infrastructure for flood protection and was very time-intensive, taking 13 years. This collaboration was initiated by ecologically committed staff members who formed a multi-scale and cross-sectoral work group, which broke down the silos of water and urban planning and was unprecedented for projects of this magnitude and involved multiple institutional scales and sectors to include not only flood and landslide protection, but also nature conservation, urban planning, water quality, waste management, tourism, recreation, and many more administrative responsibilities.



Figure 6. Isar seen from the Wittelsbacher Bridge
© Rufus46 on Wikimedia Commons (CC BY-SA 3.0)

5. MARKET UPTAKE, BUSINESS MODELS AND FINANCING APPROACHES

A growing body of evidence is emerging on the cost, benefits and cost-effectiveness of NBS, but data are largely lacking on quantified biodiversity impacts. This field has not yet reached its potential in fostering increased market uptake and replacing or more widely complementing grey infrastructure solutions.

Costs for implementing biodiversity-supporting NBS, such as restoration activities, vary a lot depending on the status of the (degraded) area to be restored and its location. OpenNESS found that restoration costs for interventions close to densely populated areas are typically higher than in more sparse areas given poor ecosystem conditions due to degradation. These costs can be compensated if beneficiaries (i.e. people) were accounted for in the assessment (Vallecillo et al., 2016).

Costs also vary with the type of ecosystem and their dynamics. Ecological processes in marine ecosystems and in particular open seas ecosystems, for example, are generally slower than land ecosystems. This means that restoration activities require a mechanism for long-term commitment that exceed typical business and political cycles (Morato et al., 2018).

While costs per hectare for restoration activities in marine ecosystems are reported as being high around the world (i.e. reported between 80,000 and 1.6 million USD for such ecosystems as coral reefs, seagrass meadows, mangrove forests, salt marshes and oyster reefs (Bayraktarov et al., 2016)), the MERCES project showed that the return on investment from the delivery of ecosystem services far outweigh these costs (Morato et al., 2018). Such services include improved water quality, enhanced fisheries, carbon sequestration and flood protection.



Figure 7. Seagrass *Halodule uninervis* © Paul Asman and Jill Lenoble on Wikimedia Commons

In order to achieve a positive cost-effectiveness ratio, long-term perspectives and the full range of ecosystem services and benefits produced by NBS need to be taken into account and monitored.

However, biodiversity assessments and monitoring frameworks are rarely established as part of NBS design and implementation in urban areas (Almassy et al., 2018). There is also a lack of accepted universal methodology, which can be applied to place monetary values across these multiple benefits and to collect data to measure the impact at the NBS-scale (i.e. not at a city scale, but rather at the intervention scale itself). The case studies in Table 9 illustrate the range of quantitative and qualitative benefits that can be provided by NBS, which were designed with the primary aim to benefit biodiversity.

TABLE 10. Quantitative and qualitative benefits of biodiverse NBS

NBS INTERVENTION	BIODIVERSITY AND OTHER BENEFITS	SOURCE
Connecting two parks with a green corridor, greening a former grey area in Athens, Greece	<ul style="list-style-type: none"> • Increase of 2.43 m²/habitant in green area access • 30 % rising biodiversity in the area • 27,9 t/y CO₂ captured • 85 % reduction of dust particles 	Almassy et al. 2018; NATURVATION
Constructed wetlands as a multipurpose GI in Gorla Maggiore, Italy	<ul style="list-style-type: none"> • Maintain and improve biodiversity • Mitigate water pollution, potentially increasing the ecological status of the Olona River • Contribute to the residents' livelihood via recreational and educational services 	OpenNESS 2018
Creation of an edible forest increase the biodiversity in an peri-urban area in Alcalá de Henares, Spain	<ul style="list-style-type: none"> • Increase biodiversity, quality and quantity of green and blue infrastructures and ecological connectivity • Restoring ecosystems & functions • Carbon sequestration and storage • increase social inclusion 	OPPLA case study, city council project

TABLE 10. Quantitative and qualitative benefits of biodiverse NBS *continued*

NBS INTERVENTION	BIODIVERSITY AND OTHER BENEFITS	SOURCE
Soil wild bees habitats - La Citadelle Park, Lille, France	<ul style="list-style-type: none"> Restoring ecosystems & functions Increase biodiversity Increased cultural richness and biodiversity 	OPPLA case study ; Nature4Cities
Ecological infrastructure in Port of Antwerp, Belgium	<ul style="list-style-type: none"> Create new habitat/ecosystem Strengthen ecosystem connectivity Protection of endangered species 	Urban Nature Atlas, NATURVATION

The benefits of ecosystem restoration activities can be evaluated by willingness-to-pay (WTP) analyses. MERCES undertook a WTP analysis for (marine) kelp forests in Norway, which show a positive and significant societal benefit associated with such restoration actions. However, the derived estimate of WTP does not reflect the total derived ecosystem service benefits of kelp forest restoration, which also include the restored kelp forest acting as a carbon storage facility and contributing to coastal protection by diminishing the impact of storm surges (Hynes et al. 2019: 17). Moreover, MERCES investigated restoration costs on the basis of case studies, such as on macroalgae restoration focused on three interventions: removal of sea urchins, (ca. 14 EUR/100m²) which prevent the return of kelp; transplantation of seeds or branches (ca. 10,500 EUR/100 m²); and using artificial reefs (ca. 42,000 EUR/100 m²) (Groeneveld et al., 2019).

OpenNESS assessed the cost-effectiveness of restoration measures by quantifying benefits resulting from the removal of invasive alien plants. This measure contributes to the improvement in the habitat conservation status, and can subsequently lead to an enhancement of the supply of ecosystem services and to support the conservation of threatened species. The results showed that when accounting for the cost-effectiveness in per capita terms, the GI identified in the “nature for people” scenario was more beneficial (as compared to the nature for nature and nature to restore scenarios), given the large share of the population that would potentially benefit from such ecosystem restoration. This provides further evidence that ecosystem restoration can contribute to improving multi-functionality while providing increased benefits for society (Vallecillo et al., 2016).

Providing evidence on the cost-effectiveness of biodiverse NBS can help to trigger financing and investments from public as well as private actors such as housing and development companies, see examples below. In addition to public funding programmes to foster NBS and biodiversity in urban and rural areas, a range of innovative financing and business models have been applied, which can benefit also other types of NBS. Examples include:

- **Participatory budgeting** - process, which allows citizens to make decisions about how a public budget is spent and gives them an opportunity to contribute their own ideas. In the context of promoting biodiverse NBS, a portion of a participatory budget can be dedicated to urban biodiversity projects (Iwaszuk et al., 2020).
- **Biodiversity offsets** - assessing biodiversity losses and gains (e.g. due to infrastructure developments) also considering ecosystem services and relational values of people to determine net outcomes and create new habitats and/or increase the ecological value of existing areas. Farmers could be paid by developers to provide biodiversity. Conservation banking schemes can be established (OPERAS, 2018).
- **Vacant space model** - the government/municipality steps back and provides space for local initiatives and (social) entrepreneurship in unused urban public space, e.g. for community gardens and farming (SEEDS, 2015, Toxopeus et al., 2019).
- **Local stewardship model** - local NBS plots and trees are valued by citizens and businesses who are willing to protect and support nature in their neighbourhood based on the direct value and sense of identity and meaning that they derive from it (Dempsey and Burton 2011, Toxopeus et al., 2019)
- **Payments for Ecosystem services** - addressing the societal demand for the delivery of some environmentally and socially beneficial outcomes in rural areas, i.e. certification schemes for organic farming, integrated conservation and development projects or premium price payments for traditional orchard meadows (Mantino et al., 2016).

The following example from Portugal illustrates how biodiversity supporting NBS can deliver a wide range of benefits, trigger innovative financing and be upscaled.

BOX 2. Sown biodiverse permanent pastures rich in legumes

Sown biodiverse pastures are a system of pastures developed in Portugal by Engineer David Crespo and promoted by a start-up called Terraprima. They are sown with mixtures of large numbers and varieties of seeds (up to 20), including native species, and the pastures can be kept for at least 10 years. These seeds contain a high proportion of legumes and can generate higher yields than those occurring in conventional seed systems. They constitute an alternative agricultural system that optimises both the economic and environmental performance of farms and are relevant for areas susceptible to agricultural abandonment and desertification.

Benefits: Legumes fix nitrogen directly from the atmosphere through microorganisms, which avoids the use of nitrogen fertilizers and linked environmental impacts and high greenhouse gas emissions. Soil organic matter and soil fertility is increased due to higher productivity, reducing soil erosion and increases water holding capacity. It was estimated that > 6,5 CO₂/ha*year of atmospheric carbon are sequestered in the long-term (Teixeira, 2010). Wild biodiversity such as insects, birds and soil biodiversity show similar levels as those occurring on natural grasslands (Teixeira, 2015).

Implementation: The Sown Biodiverse Pastures project (2009-2014) provided over 1,000 Portuguese farmers seed mixtures adapted for specific soils, technical support and knowledge to better manage their 50,000 ha land. The project sold 1 million tonnes of CO₂ to the Portuguese Carbon Fund, an operational instrument, which intends to finance several actions with positive returns regarding a decrease in GHG emissions. Farmers involved benefitted from ca. 80 % of these economic returns, with the rest being spent on project management, technical support and monitoring.

In Lisbon, such biodiverse extensive meadows were implemented as components of NBS, replacing irrigation-intensive lawns, and are now part of the green corridors. The main objectives of these NBS was to increase diversity of species, help to cope with rainwater management and soil degradation, requiring less resources (water and nitrogen fertilisers) for its maintenance (Oppla case study: Nature-based Solutions Enhancing Resilience through Urban Regeneration).



Figure 8. Biodiverse meadow in Lisbon
© CML, OPPLA case study: NBS Enhancing resilience through urban Regeneration

6. POLICY RECOMMENDATIONS AND RESEARCH GAPS

6.1 POLICY RECOMMENDATIONS

A number of recommendations have been developed to promote the mainstreaming of NBS in biodiversity and wider sectoral policies, thereby enhancing their contribution to diverse policy objectives including fostering a sustainable societal transformation. Potential instruments and means to put these recommendations into practice are also listed:

- **Cross-policy integration and support:** Mainstream biodiversity through the implementation of NBS across policies (e.g. natural water retention measures in flood risk management plans or adaptive NBS as part of regional/national adaptation strategies and plans) and significantly increase EU-level strategic investments and earmarked funding to do so across relevant policies and funding instruments (e.g. LIFE+, CAP (agri-environmental-climate measures, Natura 2000 support measures), ERDF, INTERREG).
- **Protected area network:** Expand and improve the current “functional” protected area network to ensure its representativeness, resilience, coherency, connectivity and increase in positive impacts on habitat and species conservation status by restoring degraded ecosystems and preserving and managing protected areas in a sustainable way (building on Art. 2 and 6 of the Habitats Directive), creating new habitats and GI, and designating existing areas (e.g. natural and semi-natural non-protected areas) as protected areas (building inter alia on Art. 4). Specifically, targets should be established for protected areas and non-intervention areas (so called strictly protected areas), both terrestrial and marine.
- **Conservation objective setting:** Improve coherence between conservation objectives and conservation measures, not least by ensuring spatially coherent objective setting across the national scale and appropriate accompanying monitoring schemes with measurable indicators (e.g. via EU Biodiversity Strategy 2030, national biodiversity strategies and prioritised action frameworks, action plans for selected habitats listed in the Habitats Directive). Improve conservation and restoration objectives for Natura 2000 sites by defining specific, measurable, comprehensive and realistic objectives, which can be monitored and evaluated.
- **NBS and GI:** Establish a coordinated approach⁸ to NBS/GI deployment at EU and MS level, using spatial data to map, select, assess and manage priority areas and ensure functional connectivity for species, cumulative benefits of interacting areas,

⁸ Entails a coordinated planning and implementation process taking into account different demands and corresponding benefits/services to be delivered.

ecosystem service delivery, biodiversity protection, and human health benefits. This can be done by building on existing spatial data from JRC/ETC-ULS and national/regional NBS/GI strategies and action plans. Coordinate systematic assessment and frequent monitoring of the network at EU level and mandated as reporting from site scale, linking to the status of habitats and species and integrated valuation⁹ of ecosystem services through common assessment guidelines. Such action could also entail a further development of the MAES initiative towards a more integrated valuation.

- **Building capacity:** Develop and actively disseminate guidance materials, streamlined tools and approaches for Member States, regions and cities to guide NBS mainstreaming (which sectoral policies can be supported through NBS), monitoring (e.g. indicator selection), design, funding (e.g. available EU financing instruments) and assessment, using existing platforms such as Oppla, Network Nature, and the thematic websites of the European Commission. Develop guidance to foster polycentric governance and integrated management concepts for biodiversity and natural resource management at regional/municipal level, e.g. novel arrangements in public administration that involve organisations to include not only flood and landslide protection, but also nature conservation, urban planning, water quality, waste management, tourism, recreation, and other administrative responsibilities. In addition, policies should be designed to: support empowerment and innovation (e.g. focus on outcomes and results; encourage engagement in management); focus on capacity building, facilitation and multi-actor engagement; encourage more cooperation and collective approaches; and foster local governance.

In addition to these recommendations, there is an urgent need to reflect more on the linkages between biodiversity, nature and people in European policy and research frameworks moving forward, taking relational values more strongly into account alongside economic and intrinsic values in objective setting and practice. Specifically, relational values refer to values of connectedness with nature that create meaningfulness in the lives of people and communities and nations (i.e. place attachment, identity and social belonging).

6.2 RESEARCH AND INNOVATION GAPS

A large body of evidence already exists to support the design, implementation and monitoring of NBS and measure contributions towards various objectives. However, this project review identified a number of remaining research and innovation gaps which should be addressed in future research programmes, such as Horizon Europe, to optimise NBS effectiveness, particularly regarding the delivery of biodiversity benefits. Questions requiring further research include:

⁹ i.e. accounting for the plural values of biodiversity and ecosystems that should be used to ensure that social-cultural values are adequately considered in ecosystem management and restoration.

- How should NBS be designed and implemented to effectively contribute to the protection of biodiversity (habitat structure/condition and species composition) at different scales, while also delivering other benefits (e.g. climate change mitigation and adaptation, human health, social cohesion)? How does NBS design impact the relationship between biodiversity, ecosystem functioning, ecosystem service delivery and human health (focusing in particular on functional aspects of biodiversity and impacts on species)? What trade-offs are generated based on different designs, and how can these be taken into account during decision-making processes? What are the most suitable areas for restoration and/or extending the current network of protected areas that can not only protect biodiversity, but also deliver multiple additional benefits (e.g. climate change mitigation and adaptation, recreation, sustainable agriculture production, human health)?
- What role can NBS play in the development and implementation of no net loss approaches addressing urban and rural biodiversity? What effective 'no net loss' approaches and systems exist for urban biodiversity within and beyond Europe? How can such approaches be standardised and translated into binding regulations, and at which scale is most effective?
- What are the costs and multiple benefits generated by different types and scales of NBS and hybrid solutions (combining grey and natural elements) aiming to protect biodiversity as a primary objective? How can the approaches and indicators for measuring these contributions towards biodiversity and other objectives be improved and streamlined?
- How is climate change foreseen to impact ecosystem health and individual species across the EU? How can NBS support adaptation efforts to cope with these impacts? Alternatively, what is the potential contribution of biodiverse NBS to mitigate climate change? How can EU policy support NBS uptake within the current framework or foster further efforts within new or updated policies and initiatives (e.g. EU Adaptation Strategy; EU Biodiversity Strategy to 2030; European Green Deal) to mitigate and support biodiversity's adaptation to climate change?
- How can current climate, energy and agriculture models better account for potential impacts on and changes in biodiversity and the delivery of ecosystem services, therewith contributing to the revision of associated policy frameworks? How can models contribute to improved decision-making as well as to reducing unintended negative side effects from and increasing positive benefits for other sectoral policies?
- What innovative management approaches can be applied in protected areas to help overcome key current challenges, e.g. a lack of viability or sustainability due to lack of cost-effectiveness, value for money, societal acceptance or other issues; failure to deliver expected outcomes in terms of biodiversity protection?

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8. LIST OF REVIEWED PROJECTS

ARTS (Accelerating and Rescaling Transitions to Sustainability), FP7, December 2013 – November 2016, EU contribution: € 2 996 826, [project link](#)

AQUACROSS (Knowledge, Assessment, and Management for AQUATIC Biodiversity and Ecosystem Services across EU policies), H2020, June 2015 – November 2018, EU contribution: € 6 343 614, [project link](#)

BESAFE (Biodiversity and Ecosystem Services: Arguments for our future Environment), FP7, September 2011 – August 2015, EU contribution: € 3 009 973, [project link](#)

BIOMOT (MOTivational strength of ecosystem services and alternative ways to express the value of BIOdiversity), FP7, September 2011 – August 2015, EU contribution: € 3 152 839, [project link](#)

ENABLE (Enabling Green and Blue Infrastructure Potential in Complex Social-Ecological, project link Regions), BiodivERSA, December 2016 – May 2020, Total grant: € 2,540,309 (co-funded by the EU), [project link](#)

Enroute (Enhancing Resilience of urban ecosystems through green infrastructure), JRC project, December 2016 – February 2018, [project link](#)

ESMERALDA (Enhancing ecoSystem sERvices mApping for poLicy and Decision mAking), H2020, February 2015 – July 2018, EU contribution: € 3 002 166, [project link](#)

GrowGreen (Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments), H2020, June 2017 – May 2022, EU contribution: € 11 224 058, [project link](#)

GREEN SURGE (Biocultural diversity, green infrastructure and ecosystem services), FP7, November 2013 – October 2017, EU contribution: € 5 701 837, [project link](#)

GREEN4GREY (Innovative design & development of multifunctional green & blue infrastructure in Flanders grey peri-urban landscapes), LIFE, July 2014 – December 2019, EU contribution: € 1 671 415, [project link](#)

GROW GREEN (Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments), H2020, June 2017 – May 2020, EU contribution: € 11 224 058, [project link](#)

MERCES (Marine Ecosystem Restoration in Changing European Seas), H2020, June 2016 – May 2020, EU contribution: € 6 651 118, [project link](#)

NAIAD (Nature Insurance Value: Assessment & Demonstration), H2020, December 2016 – May 2020, EU contribution: € 4 994 370, [project link](#)

NATURVATION (NATure-based Urban innoVATION), H2020, November 2016 – October 2020, EU contribution: € 7 797 878, [project link](#)

OpenNESS (Operationalization of natural capital and ecosystem services), H2020, December 2012 – May 2017, EU contribution: € 8 999 193, [project link](#)

OPERAs (Operational Potential of Ecosystem Research Applications), FP7, December 2012 – November 2017, EU contribution: € 8 997 910, [project link](#)

OPTWET (Finding optimal size and location for wetland restoration sites for best nutrient removal performance using spatial analysis and modelling); H2020, April 2015 – March 2018, EU contribution: € 240 507, [project link](#)

PATHWAYS (Transition pathways to sustainable low carbon societies), FP7, December 2013 – November 2016, EU contribution: € 2 998 498, [project link](#)

PEGASUS (Stimulating long-lasting improvements in the delivery of social, economic and environmental benefits from agricultural and forest land), H2020, March 2015 – February 2018, EU contribution: € 2 977 525, [project link](#)

PHUSICOS (“According to nature” - Solutions to reduce risk in mountain landscapes). H2020, May 2018 – April 2022, EU contribution: € 9 472 200, [project link](#)

proGInreg (‘productive Green Infrastructure for post-industrial urban regeneration’: nature for renewal), H2020, June 2018 – May 2023, EU contribution: € 10 432 512, [project link](#)

RECONNECT (Nature-based solutions for hydro-meteorological risks), H2020, September 2018 – August 2023, EU contribution: € 13 520 690, [project link](#)

REFORM (Restoring rivers for effective catchment management), FP7, November 2011 – October 2015, EU contribution: € 6 997 603, [project link](#)

SCALLUVIA (Habitat Restoration of alluvial forests and creeks within the flood controlled Scheldt estuary site Kruikeke-Bazel-Rupelmonde), LIFE, September 2013 – August 2018, € 1 744 732, [project link](#)

TESS (Transactional Environmental Support System), FP7, October 2008 - June 2011, EU contribution: € 1 801 112, [project link](#)

LIFE TreeCheck (Green Infrastructure Minimising the Urban Heat Island Effect), LIFE, September 2018 – August 2022, EU contribution: € 944 000, [project link](#)

TURas (Transitioning towards Urban Resilience and Sustainability), FP7, October 2011 – September 2016, EU contribution: € 6 813 819, [project link](#)

UNaLab (Urban nature Labs), H2020, June 2017 – May 2020, EC contribution: € 12 768 932, <https://unalab.eu/>

Urban Allotments (Urban Allotments), COST action, October 2012 – October 2016, [project link](#)

URBANGAÏA (Managing urban Biodiversity and Green Infrastructure to increase city resilience), BiodivERsA, March 2017 – February 2020, Total grant: € 692,715 (co-funded by the EU), [project link](#)

URBAN GreenUP (New Strategy for Re-Naturing Cities through Nature-Based Solutions), H2020, June 2017 – May 2020, EU contribution: € 13 970 642, [project link](#)

URBES (Urban Biodiversity and Ecosystem Services), BiodivERsA, 2010 – 2011, €2 662 281, partly funded by the EU, [project link](#)

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The EU Biodiversity Strategy for 2030 aims to secure healthy, resilient, biodiversity-rich ecosystems that deliver the range of services essential to the prosperity and well-being of citizens. Nature-based Solutions (NBS) – with healthy and biodiverse ecosystems at their core – are central to achieving the objectives of this strategy and sustainably tackling wider societal, economic and environmental challenges.

This report presents findings from a review of over 30 EU-funded research and innovation projects conducted as part of the EC's Valorisation of NBS Projects Initiative. The aim was to determine the contribution of these projects to EU biodiversity, climate and other policy objectives as well as to sustainable transition processes. The report further highlights new approaches to support the development and management of biodiverse NBS and provides insights into governance models to deliver biodiversity benefits. On this basis, the document outlines remaining research gaps and policy recommendations to promote the mainstreaming and enhanced contribution of biodiverse NBS across biodiversity and other sectoral policies, not least to foster a sustainable societal transformation in Europe and beyond.

Studies and reports

