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Literature Review

The contribution of buildings towards commitments within the EU Biodiversity Strategy for 2030 and derived policies in the Netherlands – opportunities and implementation gaps

Author: Leanne Haan

Utrecht University

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By Leanne Haan
Student number: 5734487
Daily supervisor: Prof. Niki Frantzeskaki, Utrecht University
Examiner: Prof. Dr. Chris Backes, Utrecht University

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Abstract: As the world's biodiversity continues to decline, the need for a system's change is bigger than ever. Strong and effective policies and governmental frameworks are required to facilitate this process and ensure nature conservation. Unfortunately, past experiences show that policymaking can be prone to implementation gaps. A common missing link in meeting targets and commitments is the inclusion of important sectors, such as the built environment. With the rise of different biodiversity enhancing strategies for buildings, the contribution of the built environment towards nature conservation holds great potential. In this review, we assess commitments within the European Union Biodiversity Strategy for 2030 and derived policies in the Netherlands for their acknowledgement of this potential, and identify missing links and implementation gaps. According to our analysis, the Biodiversity Strategy for 2030 promotes these strategies sufficiently, but some missing links exist in Dutch polies and legislation. On the upside, we also discovered many action plans, initiatives and strategies in play that allow a promising future for biodiversity.

Keywords: Governance, Biodiversity, Nature-based Solutions

Introduction

According to the newest IPCC report, biodiversity and ecosystems continue to decline despite measures that have been taken over the past decades[1]. Though this environmental crisis is a multifaceted issue, the IPCC report emphasizes the crucial role of national and international governments in accelerating the shift towards climate resilience and nature conservation[1,2]. In response to prior urgent calls, the European Union has developed several policies and strategies in an effort to counteract adverse events[3]. Here, biodiversity protection and restoration was put high on the agenda. In 2011, the first EU Biodiversity Strategy was adopted to halt the loss of biodiversity and ecosystem services by 2020[3]. Although this Strategy was the first to promote international action, its implementation was largely reviewed as insufficient[4]. The majority of targets was not met nor showed significant progress[5]. In 2019, the European Green Deal was launched with a broader set of goals for 2030 and 2050[6]. To make up for previous losses, a post-2020 nature restoration framework was developed under the umbrella of the European Green Deal: the Biodiversity Strategy for 2030[7]. This ambitious plan aims to bring nature back into our lives an put Europe's biodiversity on the path to recovery.

In response to these international policies, EU member states have developed rules and regulations that apply to their context. In the Netherlands, this has resulted in several agreements that promote nature conservation, such as the National Ecological Network (NEN) and Natura 2000 areas therein[8,9]. These will be eventually linked up with natural areas in neighboring countries and form a Trans-European Ecological Network (TEN-N). Additionally, the Dutch government has set out plans in the Natural Capital Implementation Agenda which are in

line with both the Convention on Biological Diversity (CBD) and the EU Biodiversity Strategy for 2030[10]. In order to comply with the European Bird- and Habitat Directive, the Netherlands adopted the Nature Conservation Act, which replaces past legislation such as the Flora and Fauna Act and the Forestry Act to better fit EU standards[11]. By combining multiple laws into one, the Netherlands aims to ease legislation processes, simplify rules for nature conservation and decentralize authorization to provinces and municipalities.

Although both European and Dutch policies set promising targets for nature conservation, they are prone to excluding sectors that highly affect the natural environment[4,12]. One of these sectors is the built environment, which is responsible for ecosystem disruption through many different processes[13]. Buildings alone contribute to biodiversity loss directly and indirectly by resource exploitation, energy use and land cover change. These anthropogenic trends are enhanced by human population growth, urbanization and urban expansion which put additional pressure onto the natural environment, causing substantial and irreversible damage[14]. With the alarming rate of biodiversity decline, there is an urgent need to change current building and construction methods.

Fortunately, scientific warnings have inspired the development of building designs that aim to enhance biodiversity[15]. No term exists that has been widely accepted for these designs, and so they go by many names. These include amongst others; ecosystem-based approaches, Nature-based Solutions (NbS) and Ecosystem-based Adaptation (EbA)[16]. European and EU-Member State policy documents generally refer to NbS, thereby displaying the growing interest into the benefits of such designs[7]. However, their true potential might not be fully recognized, as high-end policies are prone to implementation gaps as proven by the missed targets of the 2020 strategy[12,16]. In order to reach the targets set in the Biodiversity Strategy for 2030, the contribution of biodiversity enhancing strategies on buildings might be a missing link.

In this literature review, we aim to address possible missing links between biodiversity conservation targets by policymakers and the potential contribution of buildings towards them. By thoroughly reviewing commitments within the Biodiversity Strategy for 2030 and derived policies in the Netherlands, we identify possible implementation gaps and blind spots for policymakers.

Method

First, we performed an online literature search on the potential of buildings towards nature conservation and biodiversity enhancement. Here, the following searching terms were used: building(s), urban, cities, AND, nature, biodiversity, strategies, nature-inclusive. Second, we analyzed the Biodiversity Strategy for 2030 and derived policies in the Netherlands on their acknowledgement of strategies identified with the literature search. The Biodiversity Strategy consist of four pillars, of which pillar 1 and 2 are the main focus points in this research. These entail more tangible actions and commitments compared to pillar 3 and 4. Pillar 3 and 4 describe implementation conditions and were taken into consideration during the discussion writing. For these first two pillars, a pre-selection was made of the commitments for a possible link to the built environment prior to the analysis. Commitments focusing on specific areas or industries, such as rivers, pollution or agriculture, were excluded.
Each commitment was then analyzed on the following aspects: (1) the potential of building strategies towards it, (2) the acknowledgement of this potential in EU documents and initiatives related to the commitment, and (3) the acknowledgement of this potential by derived policies in the Netherlands. Through this approach, we identify missing links in policies, address potential blind spots for policymakers and propose implications for future research.

The role of buildings in biodiversity and nature conservation

Biodiversity refers to the variety of all life and the interactions within them[17]. This biological diversity is what sustains ecosystem functioning and thus a healthy planet. One of the major threats to these systems is urban expansion. The majority of studies find that urban expansion is always negatively correlated to biodiversity[18,19]. This is established by several processes. First and foremost, land-use and land-cover changes due to the development of urban areas cause both habitat loss and habitat fragmentation on a local scale[20,21]. Second, biodiversity is affected indirectly by an increased demand for resources and climate change, which is largely driven by CO2 emissions emitted by buildings[22]. On top of that, climate change creates urban conditions that are even more challenging for species to survive, such as water scarcity and urban heat island effects[23,24]. Despite the many challenges, some species have adapted to city life and have become true urban dwellers. Cities display some unique habitat features that support species by providing habitat, food and refugee from threats in the surrounding landscape[19,25]. Some species thrive even better inside urban areas than outside of them, such as peregrine falcons (*Falco peregrinus*)[26]. These urban-adapted species are generally smaller, intelligent and have general diets. Unfortunately, the conditions that are found in cities create urban biotopes in which only few species can thrive, which are usually these type generalists and nonnative species[27]. By continuous practice of conventional urban planning and building design, cities will remain biodiversity-poor areas.

The need to enhance urban biodiversity is being increasingly acknowledged and has led to the development of several biodiversity enhancing strategies[28]. On buildings, both horizontal and vertical surfaces provide opportunities[29]. They can contribute to fostering biodiversity through vegetated and non-vegetated designs. The latter are predominantly nest boxes, which can be attached to or integrated in the building façade. These have proven to be effective conservation measures for several species such as birds, bats and martens[30]. Vegetated designs on buildings fall under the umbrella term Nature-based solutions (NbS). NbS cover a wide spectrum of interventions that can touch upon multiple scales. They include all natural and semi-natural solutions, with or without managed systems and technical elements[15]. Although popular for their climate adaptation capabilities, they display many other benefits including biodiversity enhancement[31]. For buildings, two types of NbS exist: green walls (or living walls) and green roofs. Multiple studies have found that both can host may different plant and animal species. Below, a few are highlighted.

Green roofs and green walls

Sedum plants and their cultivars are preferred for green roofs, however, they can host nearly all types of garden plants[32]. Madre et al (2014) found over 176 plant species on 115 green roofs in France [33]. They can also host fungi, shrubs and small trees[34]. Regarding animal species, roofs can be habitat to arthropods, e.g., beetles, spiders, bees, and vertebrates. 53 bird and 57 butterfly species were found by Wei Wang et al.,(2017) on green roofs in the tropical climate of Singapore[35]. These species used the roofs for feeding, breeding and collecting nest material. Another study done in Australia confirmed the presence of bird species, arthropods and gastropods (slugs and snails) and even some local rare species[36]. It must be noted, though, that despite these promising results, green roofs are still far from replacing natural habitats or more complex urban green areas[37].

For green walls the benefits are similar, although plant species need to be more carefully selected. Depending on the system type, green walls can host mosses, lichen, climbers, flowering and non-flowering plants[38]. Several studies in England compared green walls to bare walls found that all animal species were more abundant on green walls. These included snail, insect, spider, and bird species[39].

The true contribution of NbS towards nature conservation still depends on multiple factors. On a design level, the surface area, height, age, substrate choice and depth, and plant diversity play a role[37]. Most importantly would be, however, the connectivity to other NbS or urban green spaces nearby. Although we are still learning about the relationships between urban biodiversity and habitat connectivity, increasing evidence suggests that connecting habitats is a crucial factor in which NbS could play a key role[40].

Commitments within EU Biodiversity Strategy for 2030; their link to building strategies and translation in Dutch policies

The Biodiversity Strategy for 2030, or “the Strategy”, was launched on May 20th by the European Commission. As a key part of the EU Green Deal, it describes bold and ambitious targets for nature conservation in Europe[7]. These targets are divided into four pillars, namely: 1. Protecting nature, 2. Restoring nature, 3. Enabling transformative change and 4. EU action to support biodiversity globally (Figure 1)[7].

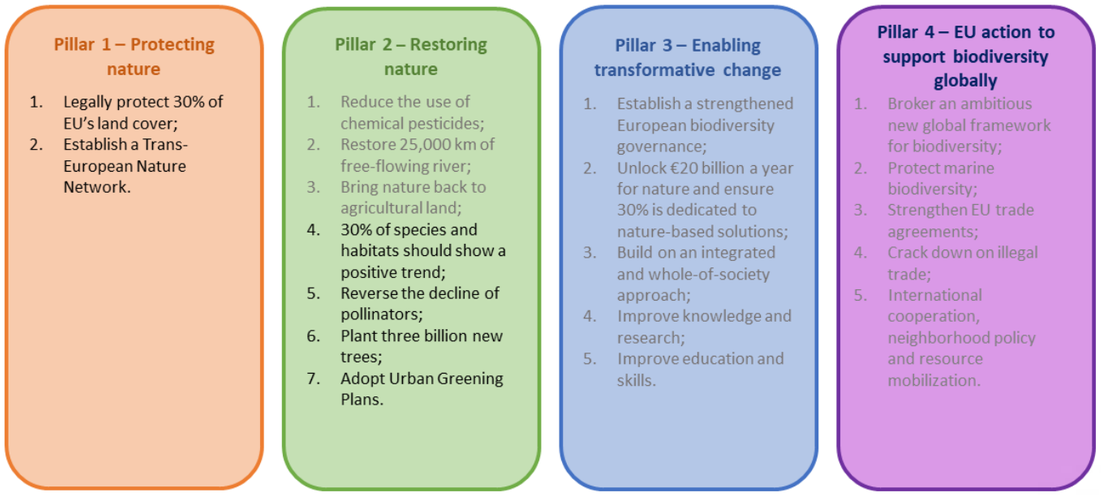

Figure 1 – The four pillars within the Biodiversity Strategy for 2030 and some of their key commitments listed. Commitments that are included in this research are indicated in black, those that are excluded are indicated in grey. Adapted from: EU (2021).

Pillar 1 – Protecting nature

In 2021, approximately 1.1 million km2 of land area in Europe was designated for nature conservation, including strict nature reserves, national parks and Natura 2000 sites[41]. For decades, the EU has plead for a connected network of these areas, named the Trans European Nature Network (TEN-N). The Biodiversity Strategy for 2030 aims to increase protected land and sea cover by 30% and improve its connectivity. Hence, the key commitments within this pillar is for Member States to enlarge existing protected areas and improve the connectivity between them. For Member States, this means they will have to protect a further 4% of land cover by 2030[7].

1. Legally protect at least 30% of EU's land cover and strictly protect one third of these areas.

Protected areas (PAs) are generally referred to as larger natural areas, such as primary and secondary forests, peatlands, grasslands and wetlands[7]. Protected areas, however, can be found in and around urban areas as well. In 2014, the UICN published a report on Urban Protected Areas including a best practices guideline[42]. In this report, they defined different categories of urban PAs in

emphasize their importance for urban areas specifically. These categories are acknowledged and used by the EU as well[41]. In order to facilitate the expansion and creation of PAs, an EU Working Document with criteria and guidelines was developed in 2022[43]. This document states that urban and peri-urban areas can be designated as either protected areas or other effective area-based conservation measures (OECMs). In both cases, the EU allows them to be counted towards the EU target of expanding protected areas if they fit the criteria. Nature-based solutions and the inclusion of buildings are not mentioned in relation to PAs in the policy. Simultaneously, no buildings or NbS have been described as parts of PAs or making a positive contribution towards PAs[44]. Thus, no missing link exists for this first commitment in pillar 1.

Protected areas in the Netherlands

The Netherlands has a total of 392 protected areas of which 162 are Natura 2000 sites[45]. These protected areas include National Parks, National Landscapes, woodlands, wetlands the Wadden sea and the Dutch part of the North Sea. Protection of these areas is legalized through the Nature Conservation Act (in Dutch Wet natuurbescherming). This Act was adopted in 2017 and protects natural reserves as well as several plant and animal species under the Bird- and Habitat Directives[46]. It describes which practices are allowed and which are restricted covering all sectors. Most of the protected areas are part of the National Ecological Network (NEN)[47]. The NEN was introduced in 1990 and has continued to expand ever since. According to current regulations, this is done by acquisition and rearrangement of agricultural land[48]. An additional 153.000 hectare is needed in order to comply with the 4% expansion as mentioned in the Biodiversity Strategy for 2030. Again, a beneficial role of buildings towards protected areas is absent in Dutch policies which is in agreement to European policies[46].

2. Establish a Trans-European Nature Network by creating ecological corridors

Though buildings cannot be interlinked to PAs, they can be linked to their connectivity. Several studies suggest that building NbS have the potential to act as stepping stones in urban habitat connectivity. Braaker et al. (2017) found that arthropod diversity increased with higher connectivity on green roofs[49]. Another study by Eakin et al.(2015) on bird populations shows a potential of green roofs in increased habitat connectivity during the breeding season[50]. Green walls that form a network tend to have a faster development of vegetation than those that are isolated[51]. It should be noted though, that the relation between NbS and connectivity is underrepresented and studies that provide solid evidence are scarce[52]. Many influencing factors have not been properly analyzed yet, such as building height, the connectivity of NbS to ground-level green spaces and synergies between NbS[37,53].

Several EU documents, among which the Biodiversity Strategy for 2030, mention the role of NbS in connecting habitats[43]. Hence, the Strategy devoted their third commitment of the first strategy to this connectivity[7]. Within this commitment, the EU calls on Member States to enhance connectivity

and create ecological corridors between PAs. The EU will be involved by promoting investments in green and blue infrastructure and assist cooperation through a variety of instruments. The Biodiversity Strategy for 2020 already acknowledged the need for a framework that helps developing, managing, and monitoring a green infrastructure (GI) network[54,55]. In response, a Green Infrastructure Strategy was developed in 2013[56]. This strategy defines GI as: *"A strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.."*. For buildings, they refer to several green features, such as green roofs and walls. Complementary documents, i.e., EU mapping and assessment of ecosystems and their services (MAES) reports, built upon these strategies and name a few additional green space elements[57]. These include: balcony green, green walls (ground based or façade-bound), green roofs (extensive or intensive) and atriums. The newest MAES report that focuses on urban ecosystems, launched in May 2016, provides an additional list of indicators that could be measured on these elements[57]. Additionally, the Biodiversity Strategy to 2030 encourages the use of the City Biodiversity Index (CBI) as a monitoring tool for evaluating the progress on urban biodiversity conservation[58]. The Green Infrastructure Strategy also led to the development of the Green City Accord, several Horizon 2020 projects, and the Urban Agenda for the EU platform[59,60]. In conclusion, the widespread interest in NbS and green elements as well as the development of multiple guidance documents on implementation make the inclusion of buildings more than sufficient in this second commitment.

Connectivity of protected areas in the Netherlands

Habitat connectivity in the Netherlands is promoted through the NEN[8]. Besides expanding existing natural areas, several interventions have been implemented that enhance their connectivity. Between 2005 and 2018, an anti-fragmentation plan (Meerjarenprogramma Ontsnippering in Dutch) was active which guided this process[61]. This action plan led to the development of eco-ducts, wildlife tunnels and passages, and marine passages all across the Netherlands. Within the given timeframe, the program was able to solve all habitat fragmentation caused by infrastructure. Currently, the action plan is only addressed when new infrastructure is being developed. In these cases, the Nature Conservation Act is also in play which legally ensures habitat connectivity[62]. Responsibility for execution lies with the provinces. The Nature Conservation Act does not specify measures or designs for connectivity and thus does not mention buildings or NbS. The provinces, on the other hand, have developed an Agenda Nature-inclusive in which is a roadmap towards a more nature-centered society[63]. Here, they briefly highlight the need for change in the current built industry but mainly plead for a better national policy and improved governmental influence.

Pillar 2 – Restoring nature

Apart from expanding the percentage of protected land area, the EU devoted a separate pillar to the restoration of existing PAs. Pillar 2 contains notably more commitments compared to pillar 1. These commitments are much more diverse and specific, ranging from pollinator abundance to water and land pollution. On top of that, there seems to be a division in commitments targeted to natural areas and those targeted to the industry. For this reason, a preselection was made as to which commitments could potentially link to the built environment. This has resulted in the following list of targets. The full list can be found in the EU Biodiversity Strategy for 2030[7].

1. At least 30% of habitats and species should show a positive trend in conservation status by 2030.

The general regulations with regards to habitats and species are integrated in the EU Birds and Habitats Directive[64]. These documents aim to ensure the conservation of a wide range of birds, animal and plant species. For birds, species trends are divided into the following categories: increasing, stable, declining, fluctuating and unknown. For habitat, conservation status include: favorable, unfavorable-inadequate, unfavorable, and unknown. The commitment under the Strategy to improve conservation status applies to habitats and birds that currently have an unfavorable status, defined by the EU as either poor or bad. Between 2013 – 2018, this accounted for 80,7% of habitats, and 39% for bird species[5]. Responsibilities for improving these trends lies with the Member States. They are obliged to console a list of species and habitats and explain criteria and measures that will be taken to achieve non-deterioration. The EU acknowledges that this could be interlinked with other commitments, such as the ones under pillar 1. Nevertheless, no guidance from the EU was provided in terms of criteria and measures and thus no link to the built environment was described[7].
The Habitats Directive protects natural and semi-natural areas and includes all Natura 2000 sites. Natural and semi-natural areas that are adjacent to urban areas tend to be more vulnerable as they are subject to multiple disturbances such as pollution, noise, light and human-wildlife conflicts[42]. Better protection and maintenance is crucial in order to reach a positive conservation status. Buildings unfortunately play a neutral, if not negative, contribution towards their ecological capacity[44]. Therefore, its unsurprising that the role of buildings is not mentioned in the Habitats directive[64].

For bird and other species conservation, it is a different story. Nest boxes have proven to be successful conservation methods for birds. For example, Altwegg et al. (2013), found an estimated 3-26% of population increase of Peregrine Falcons after installing nest boxes in urban areas[65]. This finding is supported by Fay et al., (2019), as they found that kestrels produce more chicks compared to natural open nests[66]. Not all studies agree with this, though. Dulisz et al. (2022) found that nest boxes on buildings as a conservation method for birds only cause to recover to about 50% of its original level, i.e., before building modernization[30]. They also describe the many influencing factors for success, such as the access to quality food, weather conditions and shelter from predators. Even though nest boxes may boost bird populations

in certain areas, conservation is not guaranteed. Alterative findings have been seen for bat nest boxes. Griffiths et al., (2020), studied nest box use in Australia and found very little difference in community composition between sites with and without nest boxes. Moreover, they concluded that nest box use was dominated by one generalist species, suggesting that the use of nest boxes may cause a community switch[67]. A review by Rueegger (2016) confirms this finding and expresses the concern for a competitive advantage for species commonly using the boxes68. Although nest boxes exist for martens as well, this species in largely described in relation to predating on avian nest boxes[69]. No studies were found to the effectiveness of the nest boxes on marten conservation status.
Though proven largely effective, most studies imply that putting up nest boxes is rather a matter of mitigation than true conservation. But, when species conservation is the goal, as put in the Biodiversity Strategy to 2030, nest boxes could be one of the measures. Nevertheless, they will not make a huge contribution for the majority of species. As next boxes are not recognized as potential solutions in reaching this commitments, a tiny implementation gap does exist. It must be noted though, that conservation measures applying to natural areas generally provide more benefits and thus logically receive more attention[64].

Species and habitat conservation in the Netherlands

Notably, habitats in the Netherlands are doing worse than the European average, with around 90% of habitats showing a unfavorable or unfavorable-inadequate status. Although between 2013 and 2018 24% of habitats showed improvement, another 28% further deteriorated. Similar trends are found for species, as 18% improved but 36% declined[5]. As described before, the European Bird- and Habitat directive are covered by the Dutch Nature Conservation Act[46]. The Act is in play when, amongst others, construction or renovation projects negatively affect local habitats and species. In this case, practitioners may need to adopt additional procedures or working methods that compensate for damage done to natural systems[70]. This shows that the focus is generally on mitigation or prevention of damage rather than on actual improvement. In order to change this, the Nature Conservation Act will be merged, together with multiple other laws, into a new law: the Environmental code (in Dutch Omgevingswet), from January 2024 onwards[71]. One aim is to ease legislation processes and thereby enhance implementation of nature conservation measures. An important factor within the Environmental code that could promote this is the Dutch Building Decree. The currently existing Building Decree solely describes building and construction regulations, but the merging into the Environmental code poses opportunities for compulsory biodiversity measures such as nest boxes[72]. However, since this is not yet the case, we consider the acknowledgement of buildings' contribution towards species and habitat conservation to be marginal.

2. Reverse the decline of pollinators

Pollinators are one of the key players in sustaining ecosystems and crucial for our food production system. Anthropogenic trends, such as temperature rise, drought and use of pesticides has resulted in a rapid decline of common pollinator insects worldwide[73]. Notably, some pollinator species are doing very well in cities and even show a higher species richness compared to neighboring rural sites[74]. Theodorou et al. (2020) performed a study on pollinating insects in urban areas and concluded that these can act as pollinator hotspots when properly managed. Edge density of green cover was positively correlated to most species richness, as well as landscape heterogeneity and local flower richness. Urban areas are highly dynamic and provide diverse nesting opportunities, such as wall cavities in buildings that are in favor of bumble bees. When focusing on interventions such as insect nest boxes, similar effects are found to those for birds and bats. One extensive study conducted in Canada surveyed 600 bee hotels and found that only 32.9% of them was used for nesting over a period of three years[75]. Additionally, they discovered that native wasps occupied most hotels each year compared to bees. Another study on six green roofs identified 62 wild bee species and 10 hoverfly species. They also discovered that the presence of attractive plant species and green areas within a 600 m radius were related to a higher abundance[76]. This is in line with previously discussed findings from Braaker et al., (2017), who studied arthropods populations on green roofs[77]. Fewer papers exist on green walls and pollinators. Most are conceptual, but do provide evidence for a possible positive relationship. Thorpert et al. (2022) did not collect empirical data but did compel an extensive list of plant species suitable for green walls and pollinators[78]. Similar studies were performed in Sweden[79,80]. Even though empirical data for backing up these theories is largely missing, all findings point towards a positive correlation between pollinator abundance and biodiversity-enhancing building strategies such as NbS. Nest boxes are considered a building strategy only when they are attached to the building roof or façade.

EU documents largely focus in the reintegration of pollinators into agricultural land. Since the use of pesticides is one of the key drivers for pollinator loss that also affects food security, focusing on this particular area is expected[7]. In order to monitor progress, the EU Pollinators Initiative was set up in 2018[81]. This policy mentions the possible role of green walls and roofs in enhancing pollinator habitats. Moreover, the Commission developed a guidance on pollinator-friendly cities and promote integration of pollinator conservation in urban greening plans[82]. For the latter, an Urban Greening Plan Guidance and Toolkit are currently being developed[54]. These documents, as well as the guide to pollinator-friendly cities, extensively describe different methods and ideas for pollinator enhancement in urban areas, including on buildings. They also refer to artificial nest boxes as alternative nesting habitats. Therefore, we conclude that the role of buildings in pollinator is well represented in the Biodiversity Strategy for 2030.

Pollinator protection in the Netherlands

The rapid decline of pollinators is also acknowledged by the Dutch government, since more than half of the bee species in the Netherlands is threatened with extinction[83]. The Ministry of Agriculture, Nature and Food quality developed a National Bee Strategy which aims to both conserve and increase bee populations. The main target of this strategy is: Populations of bees and other pollinators should show a stable or positive trend by 2030[84]. Stimulating bee populations growth in urban environments is one of the main focus areas. The aim is to ensure year-round food supply and provide more nesting opportunities through different initiatives of the parties involved. NbS are not included in the strategy, but bee hotels and boxes are proposed as possible solutions. Since the latter largely applies to public spaces, we conclude that the true potential of buildings could be considered more within national policies.

3. Plant three billion new trees in respect of ecological principles

Trees are vital to ecosystem functioning and provide habitat for many different species. The growing interest in their carbon storage properties have skyrocketed tree planting initiatives all over de world, with varying results[85]. A successful reforestation plan takes into account multiple factors and aims for conservation in the long run. Not necessarily the number of trees, but type, variety and longevity are most important. As many tree planting initiatives largely focus on quantity, they are sometimes associated with greenwashing. Tree planting can be done near forests but also in urban areas. Not only would green spaces in public and private areas be suitable, planting trees on green roofs is a possibility as well. Though the process requires some specific rules and calculations, tree planting is common for existing green roofs or sky gardens[86]. These are referred to as intensive green roofs, which generally require deepening planting mediums and more maintenance compared to conventional green roofs[34]. Only few studies have been done that investigate intensive roofs specifically. MacIvor et al. (2011) assessed insect diversity of intensive green roofs compared to ground-level greenery. They found a wide variety of insects on both sites[87]. Most other studies look into other ecosystem services such as thermal performance, stormwater management and air pollution mitigation[88,89].

The tree planting commitment under pillar 2 is part of the EU Forest Strategy which was developed in 2021[90]. To date, more than 10 million trees have been planted. The EU acknowledges the long term planning and monitoring that is involved in these kind of initiatives, as well as the ecological principles that ensure success. Nevertheless, the Commission only takes responsibility for counting and monitoring via their platform Map My Tree, but for tree maintenance they rely on a Declaration of honor signed by engaging parties. Though the main focus is to increase the quantity of existing forests, extending tree cover in urban areas is mentioned as well. The greening of buildings is described as a possible way to do so. Therefore, the connection to the contribution of buildings towards this commitments is considered sufficient.

Tree planting in the Netherlands

Similar to the EU Forest Strategy, the Dutch governmental tree planting initiatives largely focus on reforestation and expanding forest land cover. The Dutch Forest Strategy, developed by the Ministry of Agriculture, Nature and Food quality in 2020, did devote one of their focus areas to tree planting in and around urban areas[91]. Within the Dutch strategy, a tree is being described as a Nature-based Solutions in itself. Nature-inclusive construction is mentioned as one of the strategies, however, no specifics nor the planting of trees on green roofs is being described.

4. Adopt Urban Greening Plans for cities with >20,000 inhabitants

The development and protection of green urban spaces are becoming more important due to the many benefits for humans and urban wildlife. To facilitate this in Member States, the EU has set up an Urban Greening Platform. As mentioned before, an Urban Greening Plan Guidance document and Toolkit are currently under development[92]. The Guidance document draft proposes several targets of which some are hard requirements and others are sub-targets. The greening of buildings falls under sub-targets and is related to providing habitat that support biodiversity. Additionally, the implementation of green infrastructure is advocated for, which also includes different building strategies and NbS[56]. The draft also refers to the Green City Accord and upcoming Nature Restoration Law to align targets and indicators. The Green City Accord is directed towards cities and municipalities and addresses five priority areas, nature and biodiversity included. Here, another guidebook was developed which describes mandatory indicators: the percentage of protected natural areas, the percentage of tree canopy cover, and change in number of bird species in urban areas[93]. As described in previous sections, canopy cover and bird species richness can be interlinked to biodiversity enhancing strategies on buildings. The Nature restoration law puts an additional emphasis on nature protection and aims to strengthen local governance frameworks to support that[94]. The proposal, which was accepted in 2021, promotes the implementation of green infrastructure and nature-based solutions. Since NbS and other building related strategies are sufficiently promoted throughout these EU documents, we conclude no missing links exist.

Urban Greening plans in the Netherlands

Similar to EU initiatives, the government of the Netherlands promotes expansion of urban green spaces as well. The Ministry of Agriculture, Nature and Food Quality started several initiatives, such as an ambition document for a nature inclusive Netherlands and other actions plans that enhance urban greenery[95]. The ambition document briefly mentions the built environment but does not provide any key targets or commitments like the Biodiversity Strategy for 2030. The action plans consist of two initiatives, namely the participation project Nature-inclusive Construction and the National Rooftop plan that promotes implementation of green roofs[96]. The participation project is a network of governmental agencies, construction companies, universities and NGO and promotes activities and collaborations that upscale biodiversity strategies in the built environment. This year, they proposed a petition that

advocates for the inclusion of nature-inclusive construction into the Building Decree[97]. The petition is now being discussed for its feasibility by the House of Representatives in the Dutch parliament. It proposes several strategies such as the implementation of nest boxes in all buildings, enabling functional building rooftops (by solar panels and/or vegetation), and increase of green infrastructure land cover in public areas with 30%.
The responsibility for execution and regulation of urban greening initiatives, as well as nature conservation in general, is carried by the provinces and municipalities. These local authorities are free to adopt additional regulations, if in line with National legislation[48]. For example, the municipality of Utrecht signed the Green City Accord[98]. To facilitate implementation, the Netherlands Enterprise Agency (RVO) created a story map that displays NbS on different scales[99]. For buildings, they describe nest boxes as well as green walls an roofs. On top of that, they highlight the importance of habitat connectivity and urban green spaces. Therefore, the role of buildings in Urban Greening is considered sufficiently promoted by the Dutch government.

Conclusion and discussion

Two commitments within Pillar 1 (2/4) were included in the study design, as well as 4 commitments within Pillar 2 (4/12). We found that four out of these six commitments could potentially be linked to buildings, one could not be linked and one could partially be linked (Table 1). When assessing how the commitments correspond to this, we found that all six commitments within the Biodiversity Strategy for 2030 were in line with these findings. Therefore, we conclude that the contribution of buildings is well represented within European biodiversity targets for 2030.
For the Dutch policies its rather different. Two Biodiversity Strategy related policies did not mention the role of buildings while a link would be possible according to our study, i.e., reversing the decline of pollinators and the tree planting initiatives. Policy documents related to establishing a nature network partially acknowledged the role of buildings and therefore show a small implementation gap.

The Dutch contribution towards the Trans-European network is the development of a National Ecological Network (NEN)[8]. Although habitat connectivity is one of the key factors within this development, the majority of strategies focus on infrastructure rather than enhancing connectivity in urban areas. This does not mean biodiversity in urban areas is purposely being left out, it is simply not mentioned in relation to habitat connectivity. This can be explained by the fact that NbS are generally popular for their other ecosystem benefits, such as water retention and climate adaptation[16]. These benefits can be detected at a smaller, street-level scale, whereas biodiversity spans a much larger area[40]. On top of that, is of great importance that nearby green spaces are compatible with NbS and nest boxes in order for them to function optimally[100].

Another explanation for missing links in this research, is the uncertainty that is still associated with biodiversity enhancing strategies on buildings[52]. Although many advocate for implementation, little is known about the actual

Table 1 - Overview of analyzed commitments within the Biodiversity Strategy for 2030 and their linkages to buildings and Dutch policies. Symbols: x = no, ✓= yes, ~ = partially. Indicated in red are the divergent results and thus potential missing links.

	Link to buildings possible?	Link mentioned in EU policy?	Link mentioned in Dutch policy?
Pillar 1 - Protecting nature			
Legally protect at least 30% of European land cover	×	×	×
Establish a Trans-European nature network	✓	✓	~
Pillar 2 - Restoring nature			
Positive trend for 30% of species and habitats	~	~	~
Reverse the decline of pollinators	✓	✓	×
Plant three billion trees	✓	✓	×
Adopt Urban Greening plans	✓	✓	✓

biodiversity contribution and design optimizations. This may influence governments and policymakers in their decision whether or not to include such designs in legislation documents[15]. An additional issue here is the trade-offs that come with NbS, being additional installation costs and maintenance practices. Fortunately, the EU is working on financial subsidies through the EU taxonomy, and in the Netherlands some municipalities provide funding for green roof installations[101].

The green roof types in the Netherlands that are best promoted are extensive walls, with species of sedum plants and mosses[102]. A missed opportunity for biodiversity, as larger species such as shrubs and small trees show much more biodiversity capacity. If the government would focus more on roof selection and perhaps preparation, the benefits to biodiversity would be much greater. At the same time, this aids in the tree planting goals that the government and EU are aiming for.

Another important note is that many tools and guidelines for Member States that facilitate all these commitments are still under development[92]. This inevitably slows down implementation on a National level. Simultaneously, creating the right implementation conditions is equally important. Within the Biodiversity strategy, this is integrated in Pillar 3 and 4 which focus on e.g., education, funding, frameworks, research[7]. Several Dutch policy documents and initiatives mention these as well and thus enhance implementation in the coming years[63,96].

Implications for future research

With this study, we provide an overview of how well international and national policies acknowledge biodiversity enhancing strategies on buildings and integrate these into their policies. On top of that, we show how international policies are being translated into national policies and legislation. However, in order to make the required leaps, biodiversity commitments need to be integrated into all sectors[12]. Nature based solutions exist for other sectors as well, and so we do stimulate researchers to look into those and see how they are represented in policymaking. On top of that, further assessing the implementation conditions is needed as well, as these are key in proper facilitation.

Biodiversity loss is a global issue and knows no land and continental borders. In order to make biodiversity promoting strategies a success, a system's change is needed which requires leadership on all levels[13]. The European Biodiversity Strategy for 2030 is a great starting point and could make major changes if implemented adequately. The true potential lies with the guidelines and law proposals that are currently under development, as well as monitoring their compliance[12,103].

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