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A Typology of Nature-Based Solutions for Sustainable Development: An Analysis of Form, Function, Nomenclature, and Associated Applications

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Abstract: This study presents a typology of nature-based solutions (NbS), addressing the need for a standardized source of definitions and nomenclature, and to facilitate communication in this interdisciplinary field of theory and practice. Growing usage of the umbrella phrase 'nature-based solutions' has led to a broad inclusion of terms. With the diversity of terminology used, the full potential of NbS may be lost in the confusion of misapplied terms. Standardization and definition of commonly used nature-based nomenclature are necessary to facilitate communication in this rapidly expanding field. Through objective systemization of applications, functions, and benefits, NbS can be embraced as a standard intervention to address societal challenges and support achievement of the UN SDGs.

Keywords: forests; grasslands; green roofs; green walls; rain gardens; riparian buffer zones; sustainability; tree-based intercropping; vegetation; wetlands

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1. Introduction

In any interdisciplinary subject, individual disciplines can become siloed and specialized, making it difficult for researchers to meaningfully communicate with one another. Nature-based solutions (NbS) have been defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" [1]. The term 'nature-based solutions' is an interdisciplinary one, encompassing research from across different fields. This requires practitioners to be fluent across multiple branches of learning.

Recognition of the utility of NbS has grown in public policy, and the notion has become a fixture within the lexicon of the scientific literature [2–4]. There is broad uptake of the idea that nature itself is able to provide solutions because the concept is intuitive and logical for practitioners who lack fluency in specialized disciplines. However, the vagaries of nomenclature and inconsistent application of NbS will continue without some level of objective systemization [5–8].

The connotation of NbS and how it is situated within existing constructs may seem ambiguous. In order for implementation of NbS to occur at either a regenerative or landscape level, a coordinated and consistent understanding is essential. Flexible and non-specific nomenclature can translate into conceptual plasticity, which in turn, can reduce innovation and progress in environmental management [9]. For example, integrated landscape management has numerous definitions, however, lack of objective systemization can lead to reduced efficacy in implementation [10–12]. Standardization and definition of commonly used nature-based nomenclature are necessary to facilitate communication in this rapidly expanding field. This presents an opportunity to develop an in-depth typology of NbS, which is presented here.

Literature Review

Scientists, policy makers, and practitioners in the field of environmental management are habitually exposed to new and emergent concepts and nomenclature that can influence research streams and policy decisions. Such concepts include 'sustainable development', 'biodiversity', 'natural capital' and 'ecosystem services' [13–22]. This nomenclature has become entrenched in scientific lexicons and policy frameworks globally, with concepts reflected in policy agreements including the seminal Convention on Biological Diversity, the UN Millennium Ecosystem Assessment, and more recently the UN Sustainable Development Goals [23–27]. Over time, there has been a growing recognition of the human benefits that can be derived from the natural environment which is reflected in the expanding terminology [28–30].

Although research on the conceptual underpinnings of NbS has been somewhat limited, the terminology has developed organically [3,7,8,31,32]. For example, terms such as 'engineering with nature', 'nature-based infrastructure' and 'natural climate solutions' have become commonplace in institutional vernacular [33,34]. The definitional framework established for NbS by the International Union for Conservation of Nature (IUCN) is comprehensive and applicable globally [1], however, it does not provide deep specificity, which can render the meaning of nature-based nomenclature ambiguous. Conceptual plasticity associated with flexible nomenclature can lead to lost opportunities in the advancement of environmental management [9]. Objective systemization of nature-based nomenclature can catalyze innovation and collaboration, in addition to expediting dialogue between scientific disciplines, policy makers, and practitioners [35–37].

While reducing conceptual plasticity is important, it is essential that concepts are not oversimplified, repackaged, or misused, which can lead to information gaps and compromised decision-making [38,39]. The concept of NbS has developed at the interface of science and policy, providing an interdisciplinary bridge between specialists and laypersons alike. This necessitates contextualizing nature-based nomenclature within established lexicons, while recognizing the intersections and distinctions.

Efforts have been made to characterize NbS in different ways [1,3,31,40]. The European Commission (EC) developed its own definition that differs in focus from the IUCN definitional framework with NbS defined as "solutions inspired and supported by nature, designed to address societal challenges which are cost-effective, simultaneously provide environmental, social and economic benefits, and help build resilience" [3,40]. The US Federal Emergency Management Agency (FEMA) characterizes NbS as "sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities" [41] while the US Environmental Protection Agency (EPA) uses the terms NbS and green infrastructure interchangeably as a means for "becoming more resilient and achieving environmental, social and economic benefits" [42,43]. Within the IUCN framework, five broad categories of NbS were established to describe "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" [1]. These categories include ecosystem restoration approaches; issue-specific ecosystem-related approaches; infrastructure-related approaches; ecosystem-based management approaches; and ecosystem protection approaches [1]. This framework also provides general examples of NbS within the different categories [1]. The IUCN provides the most comprehensive viewpoint on the use of NbS to address global societal challenges such as climate change. The EC definition includes an additional focus on 'innovating with nature', that is intuitive since much of the European population resides in urban settings. EC priority areas to address with NbS include climate resilience, urban sustainability, ecosystem restoration, enhanced natural capital and the creation of green jobs [32,44,45]. FEMA's definition includes three categories of NbS including the watershed or landscape scale; the neighbourhood or site scale; and coastal areas [41], while the EPA classifies NbS applications loosely as green infrastructure [43]. In Canada, the national climate plan prioritizes NbS as a means to strengthen climate benefits through tree-planting; ecosystem conservation and restoration; and improved management and protection of land and water resources [46,47]. Regardless of the scope or context, NbS provide a mechanism to comprehensively address societal challenges.

Although there is common agreement that NbS are a good thing and that they can address key environmental and social challenges such as climate change, what is missing is a clear understanding of how NbS work as a complex intervention, their characteristics, and the multiple co-benefits that can be leveraged if strategically applied. For example, use of NbS terminology has proved contentious in the WGII Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), requiring inclusion of a specific caveat in the report that "the term 'Nature-based Solutions' is widely but not universally used in the scientific literature. The term is the subject of ongoing debate, with concerns that it may lead to the misunderstanding that NbS on its own can provide a global solution to climate change" [48]. To address this gap identified by the IPCC, a typology of the various NbS, developed through qualitative evidence synthesis, is presented here in order to address the following research objectives:

(1) To objectively systemize NbS and associated nomenclature as defined by the IUCN framework;
(2) To characterize and deconstruct NbS as complex interventions to support the United Nations Sustainable Development Goals (UN SDGs); and
(3) To reduce conceptual plasticity presented by variable NbS nomenclature through the categorization of terminology.

2. Methods

To develop this typology, a qualitative evidence synthesis was undertaken to critically assess NbS as defined by the IUCN. This typology was developed using the methodological pathway shown in Figure 1. Qualitative evidence synthesis is a type of review that explores the delivery and uptake of services in a given field to inform their prioritization [49]. This type of review enables thematic analysis that can help to explore the implementation of NbS [49] and may include conceptual models as shown in Figures 3 and 4.

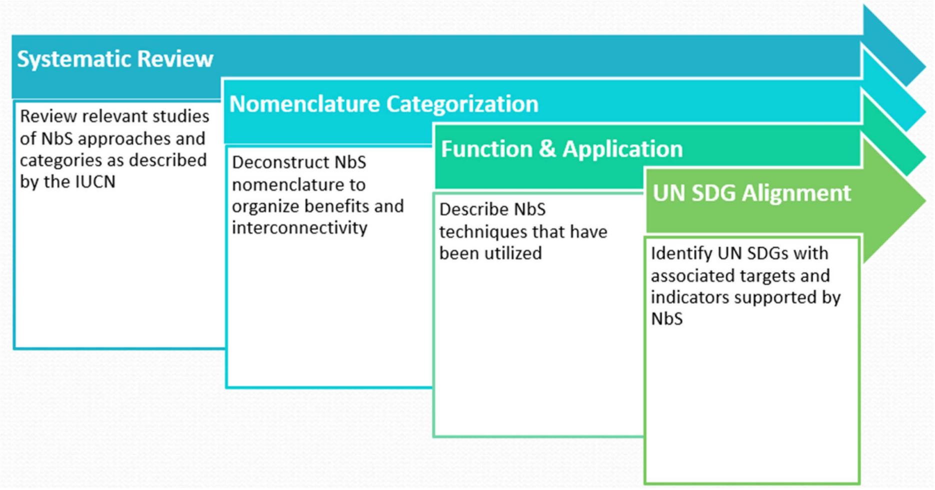


Figure 1. Methodological pathway including four specific steps that use IUCN categories to organize and characterize NbS and culminate in their alignment and connection with the UN SDGs.

The first step in the methodological pathway was to conduct a systematic review to identify relevant studies of NbS. The second step was to categorize, deconstruct, and define NbS nomenclature. The third step was identifying their unique characteristics, common applications, and multiple co-benefits. The fourth step in the methodological pathway was to identify the individual UN SDGs supported by each NbS.

2.1. Systematic Review

A systematic review was undertaken to identify relevant studies of NbS. Documents were screened and based on relevance, and full documents were retrieved to determine inclusion within the review. Searches were undertaken using scientific databases including Medline and Proquest Environmental Sciences and Pollution. Search terms used included: 'nature-based solutions'; 'ecological restoration'; 'ecological engineering'; 'forest landscape restoration'; 'ecosystem-based adaptation'; 'ecosystem-based mitigation'; 'climate adaptation'; 'ecosystem-based disaster risk reduction'; 'natural infrastructure'; 'green infrastructure'; 'integrated coastal zone management'; 'integrated water resources management'; 'area-based conservation'; 'protected area management'; 'green roofs'; 'green walls'; 'green infrastructure'; 'urban agriculture'; 'urban vegetation'; 'forestry'; 'agroforestry'; 'blue infrastructure'; and 'wetlands'. Using the Boolean search technique, each of these terms was searched in combination with 'air quality'; 'temperature'; 'stormwater'; 'biodiversity'; and 'carbon sequestration'. Duplicates were manually removed. Additional records were also identified by searching government websites. Abstracts were reviewed to screen papers and based on relevance, full papers were retrieved to determine inclusion. Articles were excluded that did not have a scientific or technical focus to support the development of a typology. As illustrated in Figure 2, a total of 164 relevant studies were identified for inclusion in this review.

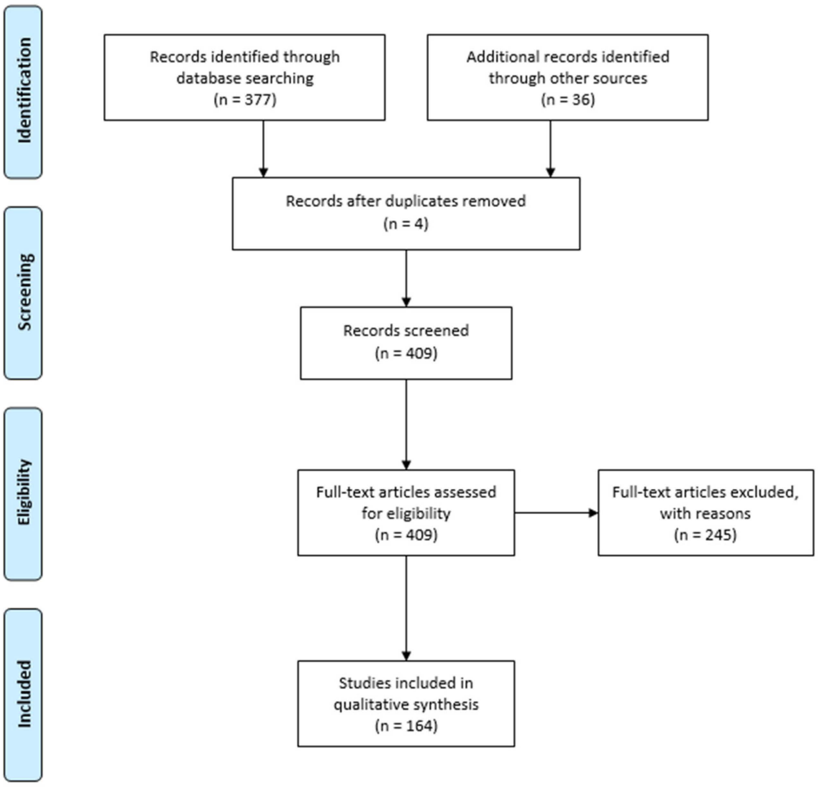


Figure 2. Overview of studies identified in the steps of the systematic review process derived from the PRISMA flow diagram (Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group, 2009).

2.2. Categorization of Nature-Based Nomenclature

As part of this qualitative evidence synthesis, the IUCN categories of NbS and associated nomenclature were categorized along two different pathways that emerged naturally during the review of literature. The first pathway is descriptive, with functional and purpose-driven terminology. The second pathway is aspirational, using language to describe a desired state of being. Nature-based nomenclature was selected and categorized as being either descriptive or aspirational (reported in Section 4.2). Through categorization of the nomenclature, NbS were analyzed and contextualized within existing terminologies, and the commonalities and variances were deconstructed. Figure 3 illustrates examples of nomenclature and naming conventions.

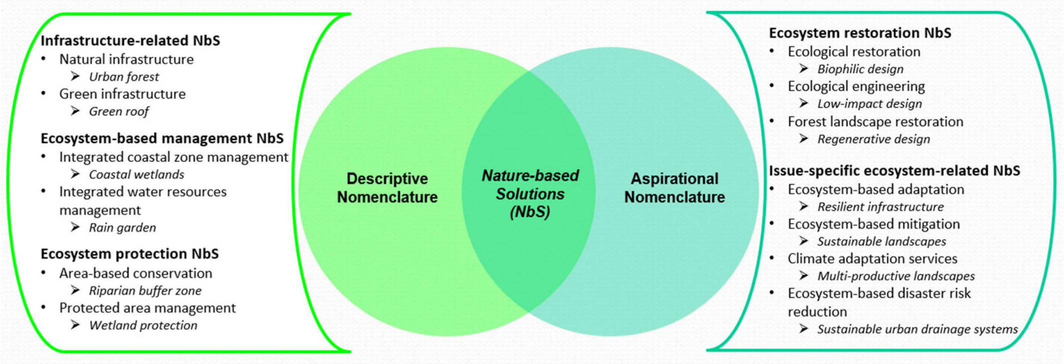


Figure 3. Examples of NbS nomenclature and naming conventions [8,50]. NbS occur at the nexus of both descriptive and aspirational categorization.

2.3. UN Sustainable Development Goal Alignment

The seventeen UN SDGs (Table 1) are global goals designed to eradicate poverty, protect the health of the planet, and improve socioeconomic outcomes. The UN SDGs each have associated targets (169) and indicators (230) with relationships and interdependencies between goals. As part of the qualitative evidence synthesis, the NbS that align with the UN SDGs were identified along with the associated SDG targets and indicators.

Table 1. UN Sustainable Development Goals.

UN Sustainable Development Goals	
Goal 1. No Poverty	End poverty in all its forms everywhere
Goal 2. Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3. Health and Well-being	Ensure healthy lives and promote well-being for all at all ages
Goal 4. Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Gender Equality	Achieve gender equality and empower all women and girls
Goal 6. Clean Water and Sanitation	Ensure availability and sustainable management of water and sanitation for all
Goal 7. Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable, and modern energy for all
Goal 8. Decent Work and Economic Growth	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
Goal 9. Industry, Innovation, and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10. Reduced Inequalities	Reduce inequality within and among countries
Goal 11. Sustainable Cities and Communities	Make cities and human settlements inclusive, safe, resilient, and sustainable
Goal 12. Responsible Production and Consumption	Ensure sustainable consumption and production patterns
Goal 13. Climate Action	Take urgent action to combat climate change and its effects
Goal 14. Life Below Water	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development

Table 1. *Cont.*

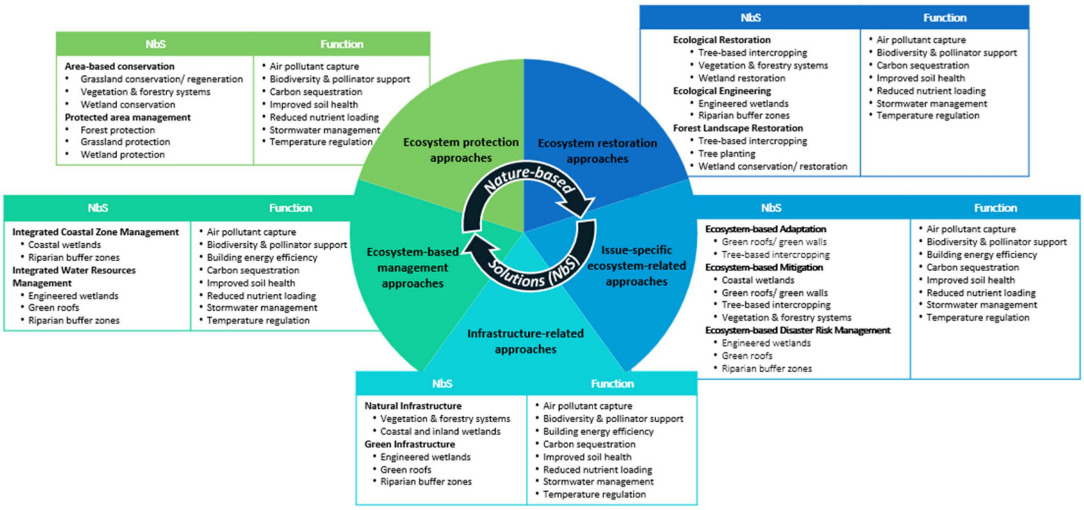
UN Sustainable Development Goals	
Goal 15. Life on Land	Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16. Peace, Justice, and Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable, and inclusive institutions at all levels
Goal 17. Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development

3. Results

Using the IUCN framework and its definitional categories as a starting point, NbS have been categorized and characterized to show how each application behaves as a complex intervention for addressing societal challenges such as climate change (UN SDG 13), with unique characteristics and multiple co-benefits that can be leveraged if strategically applied. Figure 4 shows the five categories with general examples established by the IUCN, while illustrating specific applications of NbS and their corresponding benefits. There are common functions shared between applications as illustrated, while others are exclusive to particular NbS applications.

NbS writ large support air pollutant abatement including nitrogen dioxide, ozone, and particulate matter [50–63], reduced greenhouse gas emissions, and increased carbon sequestration capacity [51,53,57,62–70]. In addition to the air pollution abatement and carbon sequestration benefits, NbS provide an efficient stormwater management alternative for decreasing sediment erosion, overland flows, and nutrient loading during extreme precipitation events [71–73].

Different applications of NbS can regulate warming temperatures by providing cooling capacity and decreasing the urban heat island effect [74–76]. This process occurs actively through evapotranspiration, and passively through surface shading [77–82]. NbS applications such as green roofs and green walls also increase energy efficiency in the built environment by providing insulation and shade, the combined effect of which decreases cooling and heating loads [83–85]. In addition, health outcomes can be improved by NbS through heat mitigation [62,63,76–78,80,81,86,87]. NbS also support food security by enhancing biodiversity; providing pollinator habitat, and improving soil health [8,63,88–96].



NbS	Function
Area-based conservation • Grassland conservation/ regeneration • Vegetation & forestry systems • Wetland conservation **Protected area management** • Forest protection • Grassland protection • Wetland protection	• Air pollutant capture • Biodiversity & pollinator support • Carbon sequestration • Improved soil health • Reduced nutrient loading • Stormwater management • Temperature regulation

NbS	Function
Ecological Restoration • Tree-based intercropping • Vegetation & forestry systems • Wetland restoration **Ecological Engineering** • Engineered wetlands • Riparian buffer zones **Forest Landscape Restoration** • Tree-based intercropping • Tree planting • Wetland conservation/ restoration	• Air pollutant capture • Biodiversity & pollinator support • Carbon sequestration • Improved soil health • Reduced nutrient loading • Stormwater management • Temperature regulation

NbS	Function
Integrated Coastal Zone Management • Coastal wetlands • Riparian buffer zones **Integrated Water Resources Management** • Engineered wetlands • Green roofs • Riparian buffer zones	• Air pollutant capture • Biodiversity & pollinator support • Building energy efficiency • Carbon sequestration • Improved soil health • Reduced nutrient loading • Stormwater management • Temperature regulation

NbS	Function
Ecosystem-based Adaptation • Green roofs/ green walls • Tree-based intercropping **Ecosystem-based Mitigation** • Coastal wetlands • Green roofs/ green walls • Tree-based intercropping • Vegetation & forestry systems **Ecosystem-based Disaster Risk Management** • Engineered wetlands • Green roofs • Riparian buffer zones	• Air pollutant capture • Biodiversity & pollinator support • Building energy efficiency • Carbon sequestration • Improved soil health • Reduced nutrient loading • Stormwater management • Temperature regulation

NbS	Function
Natural Infrastructure • Vegetation & forestry systems • Coastal and inland wetlands **Green Infrastructure** • Engineered wetlands • Green roofs • Riparian buffer zones	• Air pollutant capture • Biodiversity & pollinator support • Building energy efficiency • Carbon sequestration • Improved soil health • Reduced nutrient loading • Stormwater management • Temperature regulation

Figure 4. NbS categories and general examples established by the IUCN, are connected to a series of specific NbS and associated functions [8,50,62,63,75,96].

3.1. NbS Characteristics

Figure 4 shows the five definitional categories (e.g., infrastructure-related approaches) and general examples (e.g., green infrastructure) of NbS approaches established by the IUCN. This figure further articulates specific NbS applications that emerged during the literature review and their corresponding benefits. There are common functions shared among NbS, while others are exclusive to specific applications. These applications can be classified as: green roofs; green walls; vegetation and forestry systems that include grasslands and wetlands; and tree-based intercropping systems. Green roofs can be characterized as extensive or intensive. Extensive roofs weigh less due to shallower depth, which enables sloped roof installation, while intensive roofs have a deeper soil layer allowing for more variation in plant varietals [8,56,63,96]. Green roofs that produce food are classified as growing roofs [8,62,63,73,96–98]. Green walls can be characterized as vegetated exterior building façades that are either enveloped by plants or encompassed by planted structures that are irrigated and fertilized by automatic systems [8,62,63,65,96,99]. Vegetation and forestry systems include bioswales (e.g., vegetated ditches for drainage, stormwater storage, or groundwater infiltration); community gardens (e.g., public gardens comprised of food-producing trees, shrubs, and other plant types); rain gardens (e.g., natural or engineered depressions in the landscape comprised of trees, shrubs, grasses and other plants); riparian buffer zones (e.g., vegetated areas adjacent to a body of water and comprised of trees, shrubs, and other plant varietals); shrubs; grasslands (e.g., perennial grasslands can be tropical or temperate and grow in arid to humid conditions where precipitation levels do not support forest growth); woodlands; and trees [8,58,62,63,77,78,96,99–101]. Wetlands can be characterized as natural or engineered and can be located within inland or coastal (fresh or saltwater) watersheds. Types of wetlands include marshes, swamps, bogs, and fens [102–105]. Tree-based intercropping systems are comprised of agricultural lands where trees or shrubs are interspersed in rows alongside crops [8,62,63,88,96,101].

3.2. Ecosystem Restoration Approaches

The ‘ecosystem restoration approaches’ category (Figure 4) established by the IUCN uses aspirational nomenclature in describing the three general areas of NbS approaches that include ‘ecological restoration’, ‘ecological engineering’, and ‘forest landscape restoration’ with multiple applications of NbS cutting across the three areas.

Specific applications of NbS support ‘ecological restoration’, in the form of vegetation and forestry systems, tree-based intercropping, and wetland restoration. The implementation of riparian buffer zones and enhanced tree-planting can restore degraded ecosystems by reducing landscape fragmentation, increasing connectivity with natural areas, and providing habitat for both pollinators and wildlife [8,63]. Tree-based intercropping systems restore the ecology of watersheds by reducing runoff and filtering nutrients, pesticides, and animal waste from agricultural lands ajacent to streams, lakes, and rivers [101,106]. Wetland restoration can return landscape and watershed functions such as water storage capacity, carbon sequestration capacity, nutrient and pollutant filtration, and aquatic and terrestrial habitats [102,104]. Within the context of ‘ecological restoration’ these NbS applications specifically support the UN SDGs of ‘sustainable cities and communities’ (UN SDG 11), ‘life below water’ (UN SDG 14), and ‘life on land’ (UN SDG 15).

‘Ecological engineering’ is supported by specific applications of NbS that include bioswales, engineered wetlands, rain gardens, and riparian buffer zones. Engineered wetlands function as treatment systems using natural processes including vegetation, soil, and associated microbes to transform and remove pollutants for improved water quality. Wetland microbes can convert the depostion of organic nitrogen and phosphorous from stormwater or septic field runoff into an inorganic and useable form, essential for plant growth [107]. Bioswales and rain gardens provide extensive bioinfiltration capacity in urban settlement areas by collecting and filtering precipitation runoff from impermeable surfaces [105]. Riparian buffer zones enable bioinfiltration for evapotranspiration and groundwater recharge, in addition to reducing overland flows, sediment erosion, and pollutant discharge to receiving water bodies [101,108]. Within the context of 'ecological engineering' these NbS applications specifically support the UN SDGs of 'sustainable cities and communities' (UN SDG 11), 'life below water' (UN SDG 14), and 'life on land' (UN SDG 15).

Specific applications of NbS that support 'forest landscape restoration' include enhanced tree planting, tree-based intercropping systems, and wetland conservation and restoration. Tree-planting can stabilize the edges surrounding waterways, prevent erosion, and filter sediment runoff [101,109]. In addition, tree-planting can also provide food, shade, habitat, and corridors for wildlife [101,109]. Tree-based intercropping systems can increase soil health, bird and insect diversity, and earthworm distribution [88,91,92]. In addition, these systems protect and restore the presence of trees within the landscape. Tree-based intercropping systems can also reduce the ecological effects of agricultural production, and (re)create more biodiverse and sustainable land-use systems [88,91,92]. Conservation and restoration of wetlands are an essential component of forest restoration because wetland systems underpin forest productivity through interconnected systems of water and nutrient flows [110,111]. Within the context of 'forest landscape restoration', these NbS applications specifically support the UN SDG of 'life on land' (UN SDG 15).

3.3. Issue-Specific Ecosystem-Related Approaches

The 'issue-specific ecosystem-related approaches' category (Figure 4) established by the IUCN uses aspirational nomenclature in describing the three general areas of NbS approaches that include 'ecosystem-based adaptation', 'ecosystem-based mitigation', and 'ecosystem-based disaster risk management' with multiple applications of NbS cutting across the three areas.

Specific applications of NbS that support 'ecosystem-based adaptation' include green roofs, community gardens, green walls, and tree-based intercropping systems. As temperatures warm, green roofs and walls can provide shade and insulation against climate extremes, thereby increasing building efficiency [83–85,112,113]. In the summer, green walls shield surfaces from solar radiation while reflecting and absorbing approximately 80% of the radiation simultaneously within the foliage [112]. Growing roofs and community gardens can enhance food security by reducing food miles associated with conventional agriculture through localized production and distribution. In addition, growing roofs and community gardens can reduce pressures on conventional agricultural systems when large-scale food production is affected by extreme weather events such as drought or flooding [8,63,96,114]. Tree-based intercropping systems can provide pollinator habitat and increase biodiversity that are vital to industrial agriculture [114]. In addition, these systems can provide habitats for biological control agents, wherein plants are utilized to naturally diversify crops and chemically repel pests [115]. Tree-based intercropping systems can increase earthworm distribution and bird and insect diversity, while improving soil health and reducing the ecological impacts of agricultural production [88,91,92]. Within the context of 'ecosystem-based adaptation', these NbS applications specifically support the UN SDGs of 'no hunger' (UN SDG 2), 'sustainable cities and communities' (UN SDG 11), 'climate action' (UN SDG 13), and 'life on land' (UN SDG 15).

'Ecosystem-based mitigation' is supported by specific applications of NbS that include green roofs and walls, tree-based intercropping systems, coastal wetlands, vegetation and forestry systems, and grasslands. Both extensive and intensive green roofs can sequester carbon in their vegetated layer and organic substrate [116]. Green walls can store carbon within their foliage and biomass [65]. In addition to reducing carbon dioxide concentrations, green roofs and walls are effective in air pollution abatement through the deposition and immobilization of ozone, nitrogen dioxide, and particulate matter [8,50–59,61–63,77,78]. Compared to conventional agricultural systems, tree-based intercropping systems are effective carbon sinks, accumulating carbon within the woody elements of the tree, and providing greater sequestration capacity [91]. These systems sequester carbon because of the increased storage capacity in their biomass, stabilization of soil organic carbon, and slower decomposition of leaf litter [117,118]. Conventional agricultural systems contain lower levels of soil organic carbon than tree-based intercropping systems [92]. Certain types of coastal wetlands, also known as coastal blue carbon habitats, are comprised of mangroves, salt marshes, and sea grass beds, which can provide extensive carbon sequestration capacity because of expedited rates of growth and longevity [104,105,119,120]. The implementation of vegetation and forestry systems can sequester large quantities of carbon because of the extensive storage capacity within their biomass (e.g., foliage, branches, and root systems) [68,77,78]. For example, perennial grasslands can provide extensive carbon sequestration capacity within their root systems [100,121–124]. Unlike forests where vegetation and woody biomass are the primary source of carbon storage, grassland carbon is primarily stored underground in the soil. Within the context of ‘ecosystem-based mitigation’, these NbS applications specifically support the UN SDG of ‘climate action’ (UN SDG 13).

Specific applications of NbS support ‘ecosystem-based disaster risk management’, in the form of bioswales, green roofs, engineered wetlands, rain gardens, and riparian buffer zones. Green roofs can reduce flood risk by reducing stormwater runoff from 50 to 100 percent during extreme precipitation events depending on roof slope, substrate depth, and type of vegetation [8,71]. Flood risk is reduced when green roofs hold stormwater in the substrate, which is eventually dispersed through evapotranspiration, while any remaining water discharged from the roof is delayed by the substrate saturation period [8,71]. The burden on municipal stormwater systems is reduced by preventing sewer overflow and potential downstream erosion that can lead to flooding, water contamination, and mud slides [8,71]. Engineered wetlands can reduce flood risk, functioning as a sponge by storing water before slowly releasing it. This process decelerates the momentum of water flows while reducing flood heights and erosive potential [102]. Coastal wetlands can prevent erosion, flooding, and associated building and structural damage during storm events, due to their ability to absorb the energy created by ocean currents [105,125,126]. Bioswales and rain gardens can collect precipitation, allowing it to infiltrate into the ground while reducing runoff and filtering pollutants [106]. Riparian buffer zones can reduce flood risk and mud slides by slowing overland flows, stabilizing eroding banks, and filtering sediment runoff [8,63,96,101]. Within the context of ‘ecosystem-based disaster risk management’, these NbS applications specifically support the UN SDGs of ‘sustainable cities and communities’ (UN SDG 11), ‘climate action’ (UN SDG 13), and ‘life on land’ (UN SDG 15).

3.4. Infrastructure-Related Approaches

The ‘infrastructure-related approaches’ category (Figure 4) established by the IUCN uses descriptive nomenclature in describing the two general areas of NbS approaches that include ‘natural infrastructure’ and ‘green infrastructure’ with multiple applications of NbS cutting across both areas.

Specific applications of NbS that support ‘natural infrastructure’ include vegetation and forests, riparian buffer zones, and wetlands that individually and collectively can restore the function and composition of ecosystems. These NbS applications operate at the landscape level, providing comparable functions to those provided by conventional hard infrastructure [127–129]. For example, vegetation and forestry systems provide multiple functions including temperature regulation, air pollution abatement, and storm water management, in addition to pollinator support and wildlife habitat [8,52,58,63,77–79,93,96,101,109]. Riparian buffer zones stabilize the landscape near streams, rivers, and other water bodies while reducing flood risk and providing sediment erosion and control [8,52,63,78,79,93,96,101,109]. Inland and coastal wetlands both purify and remove pollutants, retain stormwater, and provide habitat for various avian and aquatic species [102–104]. Within the context of ‘natural infrastructure’, these NbS applications specifically support the UN SDGs of ‘sustainable cities and communities’ (UN SDG 11), ‘life below water’ (UN SDG 14), and ‘life on land’ (UN SDG 15).

'Green infrastructure' is supported by specific applications of NbS including bioswales, engineered wetlands, green roofs, rain gardens, and riparian buffer zones. Green infrastructure can enhance multiple aspects of natural ecosystems, by increasing landscape connectivity and reducing fragmentation in urban settings. Green infrastructure provides similar services to grey infrastructure. For example, engineered wetlands provide stormwater retention capacity, in addition to water treatment and pollutant removal [102,103]. Green roofs can reduce burden on municipal storm sewer infrastructure by retaining precipitation and reducing sewer overflows [8,63,71]. Bioswales and rain gardens can manage stormwater and reduce flood risk in settlement areas through bioretention, while providing supportive habitat and nourishment for pollinators, and other avian and terrestrial species [105]. Riparian buffer zones can stabilize the ground near water courses during extreme precipitation events and prevent sediment erosion and nutrient loading [8,52,63,78,79,93,96,101,109]. Within the context of 'green infrastructure', these NbS applications specifically support the UN SDG of 'sustainable cities and communities' (UN SDG 11).

3.5. Ecosystem-Based Management Approaches

The 'ecosystem-based management approaches' category (Figure 4) established by the IUCN, uses descriptive nomenclature in describing the two general areas of NbS approaches that include 'integrated coastal zone management' and 'integrated water resources management' with multiple applications of NbS cutting across both areas.

'Integrated coastal zone management' is supported by specific applications of NbS including coastal wetlands and riparian buffer zones. Coastal wetlands reduce flooding in upland areas resulting from storms and sea level rise, in addition to preventing coastline erosion that can destabilize buildings and structures [125,126]. Coastal wetlands also support the aquatic food web and various types of fisheries [130]. Riparian buffer zones stabilize banks and prevent erosion through the deceleration of overland flows and water absorption [8,52,63,78,79,93,96,101,109]. During extreme precipitation events, this process can reduce downstream flood damage [131]. Additionally, riparian buffer zones provide shade that is essential in maintaining the quality of waterways. Elevated light levels can lead to warmer water temperatures during the summer season, the combination thereof affecting algae production and aquatic species composition [132–134]. Within the context of 'integrated coastal zone management', these NbS applications specifically support the UN SDGs of 'sustainable cities and communities' (UN SDG 11), 'life below water' (UN SDG 14), and 'life on land' (UN SDG 15).

Specific applications of NbS that support 'integrated water resources management' include green roofs, engineered wetlands, and riparian buffer zones, which can individually and collectively improve watershed functions and community environmental outcomes. Green roofs retain stormwater and decrease nutrient loading and water pollution, while improving water quality and reducing flood risk across communities [8,63,71,96,135]. Additionally, when productive applications of green infrastructure are installed on rooftops to manage stormwater in the form of growing roofs, food security can also be enhanced in urban areas by reducing food miles associated with conventional agriculture through localized production and distribution [8,63,96,135]. Engineered wetlands can treat runoff and contaminated water to improve water quality and environmental outcomes [103]. While coastal wetlands perform similar functions to engineered wetlands by preventing coastline erosion that can destabilize buildings and structures [105,125,126], they also support the aquatic food web and various types of fisheries that provide an essential food source and livelihoods to communities [105,130]. Riparian buffer zones protect water quality from non-point source pollution through nutrient uptake and absorption, in addition to sediment erosion control [136,137]. In agricultural communities, riparian buffer zones can maintain soil productivity through sediment and nutrient retention while reducing pollution of neighbouring water bodies [138]. Within the context of 'integrated water resources management', these NbS applications specifically support the UN SDGs of 'sustainable cities and communities' (UN SDG 11), 'life below water' (UN SDG 14), and 'life on land' (UN SDG 15).

3.6. Ecosystem Protection Approaches

The 'ecosystem protection approaches' category (Figure 4) established by the IUCN uses descriptive nomenclature in describing the two general areas of NbS approaches that include 'area-based conservation' and 'protected area management' with multiple applications of NbS cutting across both areas.

Specific applications of NbS that support 'area-based conservation' include enhanced tree-planting, the implementation of riparian buffer zones, grassland conservation and regeneration, and wetland conservation. Well-managed conservation areas can maintain watershed functionality, while preserving species and their habitats for present and future generations by reducing stressors from urban development and human activity. Conservation areas are integral in protecting the natural environment in addition to providing opportunities for people to connect with nature. Tree-planting supports the provision of essential food, shade, habitat, and corridors for pollinators and various avian and terrestrial species [101,109]. In addition, it can stabilize areas surrounding waterways, while preventing erosion, and filtering sediment [101,109]. Riparian buffer zones can protect water quality and aquatic habitats from non-point source pollution, while enabling bioinfiltration for evapotranspiration and groundwater recharge [72,101,136,137]. Conservation and restoration of wetlands are essential because they provide numerous ecosystem services and societal benefits that include hydrologic functions for flood protection and water treatment; essential habitats for multiple aquatic, avian, insect, and terrestrial species; and climate regulation [139–142]. Perennial grassland conservation and regeneration supports landscape hydrologic functions, provides carbon sequestration capacity and essential pollinator habitat, in addition to providing erosion control [143–146]. Within the context of 'area-based conservation', these NbS applications specifically support the UN SDGs of 'sustainable cities and communities' (UN SDG 11) 'climate action' (UN SDG 13), 'life below water' (UN SDG 14), and 'life on land' (UN SDG 15).

'Protected area management' is supported by specific applications of NbS including forest protection, grassland protection; and wetland protection. Forests are complex ecosystems that provide essential habitats to numerous species on a global scale. In addition, they provide valuable ecosystem services at a societal level. Forests are declining faster than they are regenerating as a result of unsustainable natural resource development and rapid urbanization. The creation of parks, belts, zones and other areas, legally protects forests from urban development and industrial activities, which is essential in the preservation of healthy ecosystems for future generations. The benefits of forest protection include protected corridors for wildlife movement and migration, the provision of habitats for rare and endangered plant and animal species, temperature regulation and air pollution abatement, in addition to largescale biodiversity conservation [58,77,78,147–151]. Grassland ecosystems are increasingly threatened by agricultural production, industrial activity, and urban development. Protection of perennial grasslands is important to maintain ecosystem services beyond agricultural production that include biodiversity and pollinator support; extensive carbon storage, and landscape-level hydrologic functions [100,121–124,143–146]. Wetlands are increasingly threatened by land conversion, pollution, deforestation, and urban development. Designating inland and coastal wetlands as protected areas under the law can ensure the continued provision of numerous ecosystem services including biodiversity conservation of aquatic, avian, insect, and terrestrial species; extensive carbon sequestration capacity; hydrologic functions that reduce flood risk and improve water quality; and climate regulation benefits [104,105,119,120,139–142]. Within the context of 'protected area management', these NbS applications specifically support the UN SDGs of 'sustainable cities and communities' (UN SDG 11) 'climate action' (UN SDG 13), 'life below water' (UN SDG 14), and 'life on land' (UN SDG 15).

4. Discussion

Conceptual clarity and objective systemization define how NbS are perceived and how they can be used. These are critical for the effective deployment of NbS in achieving the UN SDGs. This novel and pragmatic typological approach has deconstructed how NbS work as complex interventions, their characteristics, and the multiple co-benefits that can be leveraged through strategic application, in a way that has not been attempted previously. As shown in a detailed and exhaustive fashion in Table 2, this analysis has revealed how multiple applications of NbS support the localization of individual UN SDGs and their associated targets.

Table 2. Typology of Nature-based Solutions (NbS).

IUCN Category	IUCN Example	Application	Corresponding UN SDG
Ecosystem Restoration Approaches	Ecological restoration	• Riparian buffer zones • Tree-based intercropping • Tree-planting • Wetlands	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Ecological engineering	• Engineered wetlands • Riparian buffer zones	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Forest landscape restoration	• Tree-based intercropping • Tree-planting • Wetland conservation/restoration	UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
Issue-specific Ecosystem-Related Approaches	Ecosystem-based Adaptation	• Community gardens • Green roofs • Green walls • Tree-based intercropping	UN SDG 2-No hunger | Target–2.4 UN SDG 11-Sustainable cities and communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 13-Climate action | Target–13.1 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Ecosystem-based Mitigation	• Coastal wetlands • Grasslands • Green roofs • Green walls • Tree-based intercropping • Vegetation & forests	UN SDG 13–Climate action Target–13.1
	Ecosystem-based Disaster Risk Management	• Bioswales • Engineered wetlands • Green roofs • Rain gardens • Riparian buffer zones	UN SDG 11-Sustainable cities and communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 13-Climate action | Target–13.1 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9

Table 2. *Cont.*

IUCN Category	IUCN Example	Application	Corresponding UN SDG
Infrastructure-related Approaches	Natural Infrastructure	• Bioswales • Coastal/inland wetlands • Rain gardens • Riparian buffer zones • Vegetation & forests	UN SDG 11-Sustainable cities and communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Green Infrastructure	• Bioswales • Engineered wetlands • Green roofs • Rain gardens • Riparian buffer zones	UN SDG 11-Sustainable cities and communities Targets–11a, b; 11.5; 11.6; 11.7
Ecosystem-based Management Approaches	Integrated Coastal Zone Management	• Coastal wetlands • Riparian buffer zones	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Integrated Water Resources Management	• Bioswales • Engineered wetlands • Green roofs • Rain gardens • Riparian buffer zones	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9 data
Ecosystem-based Protection Approaches	Area-based Conservation	• Forests • Grasslands • Riparian buffer zones • Wetlands	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9
	Protected Area Management	• Forests • Grasslands • Wetlands	UN SDG 11-Sustainable Cities and Communities Targets–11a, b; 11.5; 11.6; 11.7 UN SDG 14-Life below water | Targets–14.1; 14.2 UN SDG 15-Life on land Targets-15.1, 15.2, 15.3, 15.4, 15.5, 15.9

This novel typological approach presents a much needed objective systemization of NbS applications, in addition to providing a fundamental understanding of their associated benefits and functions. NbS can be applied across different spatial and temporal scales to address critical societal challenges. This innovative typology illustrates localized implementation of the five UN SDGs of Zero Hunger (2), Sustainable Cities & Communities (11), Climate Action (13), Life Below Water (14), and Life on Land (15) and their associated targets, as shown in Table 2. Each NbS application corresponds with one or more of these UN SDGs. For example, community gardens and productive (i.e., food producing) green roofs can support the UN SDG of 'No Hunger', in addition to supporting the UN SDGs of 'Sustainable Cities and Communities', 'Climate Action', and 'Life on Land' along with specific associated targets. Conversely, riparian buffer zones support the UN SDGs of 'Sustainable Cities & Communities', 'Climate Action', and 'Life on Land'. Tree-based intercropping systems sequester carbon (UN SDG 13) while enhancing both biodiversity (UN SDG 15) and food security (UN SDG 2). Table 2 provides a cross-stream translation with linkages and interdependencies between the UN SDGs.

4.1. NbS for Societal Challenges

NbS provide a complex intervention for addressing societal challenges and localizing the UN SDGs. Urban trees in the United States annually remove 711,000 metric tonnes of air pollutants with an abatement value of $4 B USD [77,93]. Across 86 Canadian cities, urban trees provide human health benefits of approximately $227 M CAD through the annual removal of 16,500 metric tonnes of air pollutants [58]. Green roofs and green walls reduce air pollutant concentrations and provide urban cooling [8,54,62,63,75] with associated improvements to respiratory health outcomes [58,74,76,77,80,81,86,87]. Exposure to vegetation and forestry systems can contribute to improved postoperative outcomes [152], reduced mortality from cardiovascular and respiratory conditions [153–156], in addition to reduced blood pressure, heart rate, and stress; increased parasympathetic nerve activity; and restoration of immune system response [157–159]. Such applications of NbS support 'sustainable cities and communities' (UN SDG 11).

Exposure to cyanobacteria through recreational activities or contaminated drinking water consumption from eutrophic water bodies has become a growing risk. Water quality in lakes and rivers can be improved by tree-based intercropping systems, which reduce reliance on pesticides and fertilizers used in conventional agriculture [88,92]. As recognition grows of the relationship between landscape fragmentation and the amplification and spread of disease in human and animal populations [93,160–163], application of NbS is becoming increasingly important in reducing infectious disease spread by providing barriers to and habitat for vectors and zoonotic reservoir populations [93]. NbS within these contexts localize 'sustainable cities and communities' (UN SDG 11) and 'life on land' (UN SDG 15).

4.2. NbS Nomenclature

Identification has implications for how NbS are understood, adopted, and prioritized. Terminology influences resource decisions and mainstream implementation. Without objective systemization of NbS nomenclature, the adoption of and investment in NbS will be sporadic. To facilitate mainstream implementation, communities and decision makers need conceptual clarity in evaluating NbS applications to address a range of environmental and societal challenges across communities.

As this qualitative evidence synthesis of NbS was undertaken, it became apparent that the terminology can vary, following two different classification streams, as noted in Section 2.2. The first stream is descriptive, with functional and purpose-driven nomenclature. The second stream is aspirational, describing a desired state of being. For the purposes of this review, common NbS terminology was used and delineated into two distinct categories. As illustrated in Figure 3, NbS nomenclature can follow different naming conventions. Descriptive NbS nomenclature is specific and provides an indication of purpose and function. For example, 'green walls' and 'vertical gardens and greening systems' can be used interchangeably to describe NbS shape and type. Conversely, NbS aspirational nomenclature is vague, fluid, and open to interpretation. For example, 'living architecture' can include green and growing roofs, green walls, rooftop farms and gardens, and vertical gardens and greening systems. The aspirational term 'sustainable urban drainage systems' is common in the United Kingdom, where it is used to describe bioswales, community gardens, green and growing roofs, green walls, street trees, rain gardens, and urban forests [72,164]. A cross-stream translation between descriptive and aspirational nomenclature is provided in Table 3.

As a novel contribution of this work, through this key nomenclature categorization, it is possible to deconstruct the NbS concept and how it is translated across disciplines. Deconstructing the nomenclature of NbS can facilitate the organization of direct and indirect impacts, their complexities, and interconnectivity. NbS provide a practical and accessible intervention to localize the UN SDGs and address societal challenges such as climate change. This intervention is key to forwarding progress with the UN SDGs in a less ambiguous fashion than is the current state.

Table 3. Nomenclature comparison [8,50].

Descriptive Nomenclature	Aspirational Nomenclature
Bioswales	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Coastal/Inland wetlands	Natural infrastructure, Resilient infrastructure, Sustainable landscapes
Community gardens	Multi-productive landscapes, Sustainable landscapes
Engineered wetlands	Biophilic design, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Forest & vegetation systems	Living architecture, Natural infrastructure, Resilient infrastructure, Sustainable landscapes, Sustainable urban drainage systems
Grasslands	Multi-productive landscapes, Natural infrastructure, Sustainable landscapes
Green roofs	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Green walls	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Growing roofs	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Rain gardens	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Riparian buffer zones	Low-impact design, Natural infrastructure, Regenerative urban design, Resilient infrastructure, Sustainable landscapes, Sustainable urban drainage systems
Street trees	Biophilic design, Low-impact design, Natural infrastructure, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems
Tree-based intercropping systems	Multi-productive landscapes, Sustainable landscapes
Vertical gardens/greening systems	Biophilic design, Living architecture, Low-impact design, Regenerative urban design, Resilient infrastructure, Sustainable urban drainage systems

4.3. Integration of NbS in Environmental Policy

Without a common typology, integration of NbS in environmental policy and mainstream implementation will be sporadic. Differences in nomenclature present a unique challenge for policymakers in whether to adopt NbS as a complex intervention and allocate resources for implementation. To facilitate the broad implementation of NbS, policymakers need clear language and guidance to select NbS applications that are most appropriate for their communities. While there is common agreement that NbS may provide a comprehensive mechanism for addressing societal challenges, what has been missing is a clear understanding of how they function, their characteristics, and the multiple co-benefits that can be leveraged if strategically applied.

For example, there is no integrated public policy for NbS implementation in Canada; however, there are explicit linkages between national climate change policy and NbS writ large. The 'Healthy Environment and a Healthy Economy' is Canada's climate plan that identifies NbS as an essential component under its 'natural climate solutions' pillar [165]. This plan is focused on strengthening climate benefits by planting trees, ecosystem conservation and restoration, and improved management of land and water through dedicated financial investment in NbS across Canada's provinces and territories [46].

At the international level, the IPCC has underscored the importance of NbS as a mechanism for enhancing urban carbon sinks and undertaking ecosystem-based adaptation to transform the built environment through phytoremediation [166]. In addition, the IPCC further indicates that NbS, including both green roofs and tree-based intercropping systems, can create synergies between climate change mitigation and adaptation [167]. The European Union promotes NbS as a way to enhance natural ecosystem services and protect biodiversity [168,169]. In the United States, the Environmental Protection Agency narrowly defines NbS under the Clean Water Act as an effective mechanism to address stormwater issues and reduce flood risk [40].

NbS provide a practical and accessible means to address societal challenges such as climate change. The purpose of this typology is to provide a comprehensive understanding of how NbS work as a complex intervention, their characteristics, and the multiple co-benefits that can be leveraged. With a systematic accounting of the applications, functions, and benefits of NbS, this may stimulate communities and decision-makers to adopt NbS as a standard intervention. In environmental policy making, tensions can arise between the availability of fiscal resources, political will, and intentions to protect the environment. This typology presents an opportunity to create greater coherence and integration of NbS in environmental policy, while supporting localization of the UN SDGs.

5. Conclusions

Conceptual plasticity and variable nomenclature present a unique challenge in whether to adopt NbS as a multi-faceted intervention and allocate resources for implementation. Without a typology to enable a shared understanding, uptake and implementation of NbS can be erratic. There has been sporadic integration of NbS in environmental policy thus far. To facilitate widespread NbS implementation, scientists, policy makers, and practitioners need clear terminology to evaluate which NbS applications are most appropriate in addressing the environmental and societal challenges faced by different communities, globally. Effective NbS applications address environmental, economic, and human health challenges. In this work, a novel typology was developed to provide a comprehensive understanding of how NbS function as a complex intervention, their characteristics, and the multiple co-benefits that can be strategically leveraged, in order to reduce the ambiguity that shrouds the current nomenclature. Through objective systemization of applications, functions, and benefits, NbS can be embraced as a standard intervention to address societal challenges and support the achievement of the UN SDGs.

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References

1. Cohen-Shacham, E.; Walters, G.; Janzen, C.; Maginnis, S. (Eds.) *Nature-Based Solutions to Address Global Societal Challenges*; IUCN: Gland, Switzerland, 2016; Volume 13, p. 97. ISBN 978-2-8317-1812-5.
2. Kabisch, N.; Frantzeskaki, N.; Pauleit, S.; Naumann, S.; Davis, M.; Artmann, M.; Haase, D.; Knapp, S.; Korn, H.; Stadler, J.; et al. Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecol. Soc.* **2016**, *21*, 39. [CrossRef]
3. Raymond, C.M.; Frantzeskaki, N.; Kabisch, N.; Berry, P.; Breil, M.; Nita, M.R.; Geneletti, D.; Calfapietra, C. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environ. Sci. Policy* **2017**, *77*, 15–24. [CrossRef]
4. Keesstra, S.; Nunes, J.; Novara, A.; Finger, D.; Avelar, D.; Kalantari, Z.; Cerdà, A. The superior effect of nature based solutions in land management for enhancing ecosystem services. *Sci. Total Environ.* **2018**, *610–611*, 997–1009. [CrossRef] [PubMed]
5. Davis, K. Intersectionality as buzzword: A sociology of science perspective on what makes a feminist theory successful. *Fem. Theor.* **2008**, *9*, 67–85. [CrossRef]
6. Brandt, P.; Ernst, A.; Gralla, F.; Luederitz, C.; Lang, D.J.; Newig, J.; Reinert, F.; Abson, D.J.; von Wehrden, H. A review of transdisciplinary research in sustainability science. *Ecol. Econ.* **2013**, *92*, 1–15. [CrossRef]
7. Nesshöver, C.; Assmuth, T.; Irvine, K.N.; Rusch, G.M.; Waylen, K.A.; Delbaere, B.; Haase, D.; Jones-Walters, L.; Keune, H.; Kovacs, E.; et al. The science, policy and practice of nature-based solutions: An interdisciplinary perspective. *Sci. Total Environ.* **2017**, *579*, 1215–1227. [CrossRef]

8. Anderson, V.; Gough, W.A. Form, Function, and Nomenclature: Deconstructing Green Infrastructure and its Role in a Changing Climate. In *Climate Change and Extreme Events*; Fares, A., Ed.; Elsevier: Amsterdam, The Netherlands, 2021; ISBN U1104201903351.
9. Waylen, K.A.; Hastings, E.J.; Banks, E.A.; Holstead, K.L.; Irvine, R.J.; Blackstock, K.L. The Need to Disentangle Key Concepts from Ecosystem-Approach Jargon. *Conserv. Biol.* **2014**, *28*, 1215–1224. [CrossRef]
10. Sayer, J.; Sunderland, T.; Ghazoul, J.; Pfund, J.-L.; Sheil, D.; Meijaard, E.; Venter, M.; Boedhihartono, A.K.; Day, M.; Garcia, C.; et al. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 8349–8356. [CrossRef]
11. Denier, L.; Scherr, S.; Shames, S.; Chatterton, P.; Hovani, L.; Stam, N. *The Little Sustainable Landscapes Book*; Global Canopy Programme: Oxford, UK, 2015.
12. Erbaugh, J.; Agrawal, A. Clarifying the landscape approach: A Letter to the Editor on Integrated landscape approaches to managing social and environmental issues in the tropics. *Glob. Chang. Biol.* **2017**, *23*, 4453–4454. [CrossRef]
13. Schumacher, E.F. Small is Beautiful: Economics As if People Mattered (an excerpt) (translated by Daniil Aronson). *J. Econ. Sociol.* **2012**, *13*. [CrossRef]
14. Brundtland, G.; Khalid, M.; Agnelli, S.; Al-Athel, S.; Chidzero, B.; Fadika, L. The Brundtland report: 'Our common future'. *Med. War* **1988**, *4*, 17–25.
15. Wilson, E.O. *Biodiversity*; National Academy Press: New York, NY, USA, 1988.
16. Takacs, D. *The Idea of Biodiversity: Philosophies of Paradise*; The Johns Hopkins University Press: Baltimore, MD, USA, 1996.
17. Costanza, R.; Daly, H.E. Natural Capital and Sustainable Development. *Conserv. Biol.* **1992**, *6*, 37–46. [CrossRef]
18. Jansson, A. *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*; Island Press: Washington, DC, USA, 1994.
19. Daily, G. *Nature's Services: Societal Dependence on Natural Ecosystems*; Island Press: Washington, DC, USA, 1997.
20. Costanza, R.; D'Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R.V.; Paruelo, J.; et al. The value of ecosystem services: Putting the issues in perspective. *Ecol. Econ.* **1998**, *25*, 67–72. [CrossRef]
21. Gómez-Baggethun, E.; de Groot, R.; Lomas, P.L.; Montes, C. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecol. Econ.* **2010**, *69*, 1209–1218. [CrossRef]
22. Daly, H.E.; Farley, J. *Ecological Economics: Principles and Applications*; Island Press: Washington, DC, USA, 2011.
23. UNEP. *Convention on Biological Diversity*; 1760 UNTS 79; 31 ILM 818 (1992); UNEP: Nairobi, Kenya, 1993.
24. MA. *Millennium Ecosystem Assessment-Ecosystems and Human Well-Being*; Island Press: Washington, DC, USA, 2005; Volume 5.
25. UNEP. *Report of the Third ad Hoc Intergovernmental and Multi-Stakeholder Meeting on an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services ("Busan Outcome")-UNEP/IPBES/3/3*; UNEP: Nairobi, Kenya, 2010.
26. United Nations. *Sustainable Development Goals*; UN: San Francisco, CA, USA, 2016.
27. Admiraal, J.; Musters, C.; de Snoo, G. The loss of biodiversity conservation in EU research programmes: Thematic shifts in biodiversity wording in the environment themes of EU research programmes FP7 and Horizon 2020. *J. Nat. Conserv.* **2016**, *30*, 12–18. [CrossRef]
28. Nesshöver, C.; Prip, C.; Wittmer, H. Biodiversity Governance: A Global Perspective from the Convention on Biological Diversity. In *Biodiversity in the Green Economy*; Gaspartos, A., Willis, K.J., Eds.; Routledge: London, UK, 2015; pp. 289–308.
29. Díaz, S.; Demissew, S.; Carabias, J.; Joly, C.; Lonsdale, M.; Ash, N.; Larigauderie, A.; Adhikari, J.R.; Arico, S.; Báldi, A.; et al. The IPBES Conceptual Framework—connecting nature and people. *Curr. Opin. Environ. Sustain.* **2014**, *14*, 1–16. [CrossRef]
30. Whitmee, S.; Haines, A.; Beyrer, C.; Boltz, F.; Capon, A.G.; de Souza Dias, B.F.; Ezeh, A.; Frumkin, H.; Gong, P.; Head, P.; et al. Safeguarding human health in the Anthropocene epoch: Report of The Rockefeller Foundation—Lancet Commission on planetary health. *Lancet* **2015**, *386*, 1973–2028, Erratum in **2015**, *386*, 1944. [CrossRef]
31. Eggermont, H.; Balian, E.; Azevedo, J.M.N.; Beumer, V.; Brodin, T.; Claudet, J.; Fady, B.; Grube, M.; Keune, H.; Lamarque, P.; et al. Nature-based Solutions: New Influence for Environmental Management and Research in Europe. *GAIA-Ecol. Perspect. Sci. Soc.* **2015**, *24*, 243–248. [CrossRef]
32. Maes, J.; Jacobs, S. Nature-Based Solutions for Europe's Sustainable Development. *Conserv. Lett.* **2015**, *10*, 121–124. [CrossRef]
33. US Army Corps of Engineers. Coastal Risk Reduction and Resilience. CWTS 2013-3. In *Directorate of Civil Works*; US Army Corps of Engineers: Washington, DC, USA, 2013.
34. Natural Climate Solutions Fund. Available online: https://www.canada.ca/en/campaign/natural-climate-solutions.html (accessed on 1 May 2022).
35. Abson, D.J.; von Wehrden, H.; Baumgärtner, S.; Fischer, J.; Hanspach, J.; Härdtle, W.; Heinrichs, H.; Klein, A.M.; Lang, D.J.; Martens, P.; et al. Ecosystem services as a boundary object for sustainability. *Ecol. Econ.* **2014**, *103*, 29–37. [CrossRef]
36. Star, S.L.; Griesemer, J.R. Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939. *Soc. Stud. Sci.* **1989**, *19*, 387–420. [CrossRef]
37. Brand, F.S.; Jax, K. Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Concept and a Boundary Object. *Ecol. Soc.* **2007**, *12*, 23. [CrossRef]
38. Bennett, E.M.; Peterson, G.D.; Gordon, L.J. Understanding relationships among multiple ecosystem services. *Ecol. Lett.* **2009**, *12*, 1394–1404. [CrossRef] [PubMed]
39. Ring, I.; Hansjürgens, B.; Elmqvist, T.; Wittmer, H.; Sukhdev, P. Challenges in framing the economics of ecosystems and biodiversity: The TEEB initiative. *Curr. Opin. Environ. Sustain.* **2010**, *2*, 15–26. [CrossRef]

40. European Commission. *Towards an EU Research and Innovation Policy Agenda for Nature-Based Solutions & Re-naturing Cities-Final Report of the Horizon 2020 Expert Group*; European Commission, Directorate General for Research and Innovation: Brussels, Belgium, 2015; p. 74.
41. FEMA. Building Community Resilience with Nature-Based Solutions. 2021. Available online: https://www.fema.gov/sites/default/files/documents/fema_riskmap-nature-based-solutions-guide_2021.pdf (accessed on 1 May 2022).
42. U.S. Environmental Protection Agency. What Is Green Infrastructure? Available online: https://www.epa.gov/greeninfrastructure/what-green-infrastructure. (accessed on 1 May 2022).
43. U.S. Environmental Protection Agency. Green Infrastructure Federal Collaborative. Available online: https://www.epa.gov/green-infrastructure/green-infrastructure-federal-collaborative. (accessed on 1 May 2022).
44. Faivre, N.; Fritz, M.; Freitas, T.; de Boissezon, B.; Vandewoestijne, S. Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. *Environ. Res.* **2017**, *159*, 509–518. [CrossRef]
45. Raymond, C.M.; Berry, P.; Breil, M. An Impact Evaluation Framework to Support Planning and Evaluation of Nature-based Solutions Projects. In *Report Prepared by the EKLIPSE Expert Working Group on Nature-Based Solutions to Promote Climate Resilience in Urban Areas*; Centre for Ecology & Hydrology: Wallingford, UK, 2017.
46. Nature Smart Climate Solutions Fund. Available online: https://www.canada.ca/en/environment-climate-change/services/environmental-funding/programs/nature-smart-climate-solutions-fund.html (accessed on 1 May 2022).
47. Government of Canada. Healthy Environment and a Healthy Economy. 2020. Available online: https://www.canada.ca/content/dam/eccc/documents/pdf/climatechange/climateplan/healthy_environment_healthy_economy_plan.pdf (accessed on 1 May 2022).
48. Intergovernmental Panel on Climate Change (IPCC). Climate Change 2022: Impacts, Adaptation, and Vulnerability–Summary for Policy Makers. 2022. Available online: https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf (accessed on 1 May 2022).
49. Grant, M.J.; Booth, A. A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Inf. Libr. J.* **2009**, *26*, 91–108. [CrossRef]
50. Anderson, V. Deep Adaptation: A Framework for Climate Resilience, Decarbonization and Planetary Health. Ph.D. Thesis, University of Toronto, Toronto, ON, Canada, 2018. Available online: https://tspace.library.utoronto.ca/ (accessed on 1 May 2022).
51. Alexandri, E.; Jones, P. Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates. *Build. Environ.* **2008**, *43*, 480–493. [CrossRef]
52. Yang, J.; Yu, Q.; Gong, P. Quantifying air pollution removal by green roofs in Chicago. *Atmos Environ.* **2008**, *42*, 7266–7273. [CrossRef]
53. Bowler, D.E.; Buyung-Ali, L.; Knight, T.M.; Pullin, A.S. Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landsc. Urban Plan.* **2010**, *97*, 147–155. [CrossRef]
54. Baik, J.-J.; Kwak, K.-H.; Park, S.-B.; Ryu, Y.-H. Effects of building roof greening on air quality in street canyons. *Atmos. Environ.* **2012**, *61*, 48–55. [CrossRef]
55. Speak, A.F.; Rothwell, J.J.; Lindley, S.J.; Smith, C.L. Urban particulate pollution reduction by four species of green roof vegetation in a UK city. *Atmos Environ.* **2012**, *61*, 283–293. [CrossRef]
56. Gago, E.J.; Roldan, J.; Pacheco-Torres, R.; Ordóñez, J. The city and urban heat islands: A review of strategies to mitigate adverse effects. *Renew. Sust. Energ. Rev.* **2013**, *25*, 749–758. [CrossRef]
57. Berardi, U.; AmirHosein, G.H.; Ali, G. State-of-the-art analysis of the environmental benefits of green roofs. *Appl. Energy* **2014**, *115*, 411–428. [CrossRef]
58. Feng, H.; Hewage, K. Lifecycle assessment of living walls: Air purification and energy performance. *J. Clean. Prod.* **2014**, *69*, 91–99. [CrossRef]
59. Nowak, D.J.; Hirabayashi, S.; Doyle, M.; McGovern, M.; Pasher, J. Air pollution removal by urban forests in Canada and its effect on air quality and human health. *Urban For. Urban Green.* **2018**, *29*, 40–48. [CrossRef]
60. Sicard, P.; Agathokleous, E.; Araminiene, V.; Carrari, E.; Hoshika, Y.; De Marco, A.; Paoletti, E. Should we see urban trees as effective solutions to reduce increasing ozone levels in cities? *Environ. Pollut.* **2018**, *243*, 163–176. [CrossRef]
61. Gourdji, S. Review of plants to mitigate particulate matter, ozone as well as nitrogen dioxide air pollutants and applicable recommendations for green roofs in Montreal, Quebec. *Environ. Pollut.* **2018**, *241*, 378–387. [CrossRef]
62. Anderson, V.; Gough, W.A. Evaluating the potential of nature-based solutions to reduce ozone, nitrogen dioxide, and carbon dioxide through a multi-type green infrastructure study in Ontario, Canada. *City Environ. Interact.* **2020**, *6*, 100043. [CrossRef]
63. Anderson, V.; Gough, W.A. Nature-Based Resilience: A Multi-Type Evaluation of Productive Green Infrastructure in Agricultural Settings in Ontario, Canada. *Atmosphere* **2021**, *12*, 1183. [CrossRef]
64. Li, J.; Wai, O.W.H.; Li, Y.S.; Zhan, J.; Ho, Y.A.; Li, J.; Lam, E. Effect of green roofs on ambient CO2 concentration. *Build. Environ.* **2010**, *45*, 2644–2651. [CrossRef]
65. Marchi, M.; Pulselli, R.M.; Marchettini, N.; Pulselli, F.M.; Bastianoni, S. Carbon dioxide sequestration model of a vertical greenery system. *Ecol. Model.* **2015**, *306*, 46–56. [CrossRef]
66. Li, W.C.; Yeung, K.K.A. A comprehensive study of green roof performance from environmental perspective. *Int. J. Sustain. Built Environ.* **2014**, *3*, 127–134. [CrossRef]

67. Hall, J.M.; Handley, J.F.; Ennos, A.R. The potential of tree planting to climate-proof high density residential areas in Manchester, UK. *Landsc. Urban Plan.* **2012**, *104*, 410–417. [CrossRef]
68. Velasco, E.; Roth, M.; Norford, L.; Molina, L.T. Does urban vegetation enhance carbon sequestration? *Landsc. Urban Plan.* **2016**, *148*, 99–107. [CrossRef]
69. Fargione, J.E.; Bassett, S.; Boucher, T.; Bridgham, S.D.; Conant, R.T.; Cook-Patton, S.C.; Griscom, B.W. Natural climate solutions for the United States. *Sci. Adv.* **2018**, *4*, eaat1869. [CrossRef]
70. Hoffman, B.M.; Lukoyanov, D.; Dean, D.R.; Seefeldt, L.C. Nitrogenase: A draft mechanism. *AccChem. Res.* **2013**, *46*, 87–95. [CrossRef]
71. Rowe, D.B. Green roofs as a means of pollution abatement. *Environ. Pollut.* **2011**, *159*, 2100–2110. [CrossRef]
72. Ellis, J. Sustainable surface water management and green infrastructure in UK urban catchment planning. *J. Environ. Plan. Manag.* **2013**, *56*, 24–41. [CrossRef]
73. Lin, B.B.; Philpott, S.M.; Jha, S. The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps. *Basic Appl. Ecol.* **2015**, *16*, 189–201. [CrossRef]
74. Susca, T.; Gaffin, S.R.; Dell'Osso, G.R. Positive effects of vegetation: Urban heat island and green roofs. *Environ. Pollut.* **2011**, *159*, 2119–2126. [CrossRef]
75. Anderson, V.; Gough, W.A. Nature-based cooling potential: A multi-type green infrastructure evaluation in Toronto, Ontario, Canada. *Int. J. Biometeorol.* **2021**, *66*, 397–410. [CrossRef]
76. Tan, C.L.; Wong, N.H.; Jusuf, S.K. Effects of vertical greenery on mean radiant temperature in the tropical urban environment. *Landsc. Urban Plan.* **2014**, *127*, 52–64. [CrossRef]
77. Nowak, D.J.; Crane, D.E.; Stevens, J.C. Air pollution removal by urban trees and shrubs in the United States. *Urban For. Urban Green.* **2006**, *4*, 115–123. [CrossRef]
78. Nowak, D.J. Institutionalizing urban forestry as a "biotechnology" to improve environmental quality. *Urban For. Urban Green.* **2006**, *5*, 93–100. [CrossRef]
79. Kleerekoper, L.; van Esch, M.; Salcedo, T.B. How to make a city climate-proof, addressing the urban heat island effect. *Resour. Conserv. Recycl.* **2012**, *64*, 30–38. [CrossRef]
80. Rao, M.; George, L.; Rosenstiehl, T.N.; Shandas, V.; Dinno, A. Assessing the relationship among urban trees, nitrogen dioxide, and respiratory health. *Environ. Pollut* **2014**, *194*, 96–104. [CrossRef]
81. King, K.; Johnson, S.; Kheirbek, I.; Lu, J.; Matte, T. Differences in magnitude and spatial distribution of urban forest pollution deposition rates, air pollution emissions, and ambient neighborhood air quality in New York City. *Landsc. Urban Plan.* **2014**, *128*, 14–22. [CrossRef]
82. Janhäll, S. Review on urban vegetation and particle air pollution–deposition and dispersion. *Atmos. Environ.* **2015**, *105*, 130–137. [CrossRef]
83. Demuzere, M.; Orru, K.; Heidrich, O.; Olazabal, E.; Geneletti, D.; Orru, H.; Bhave, A.G.; Mittal, N.; Feliu, E.; Faehnle, M. Mitigating and adapting to climate change: Multi-functional and multi-scale assessment of green urban infrastructure. *J. Environ. Manag.* **2014**, *146*, 107–115. [CrossRef]
84. Berardi, U. The outdoor microclimate benefits and energy saving resulting from green roofs retrofits. *Energy Build.* **2016**, *121*, 217–229. [CrossRef]
85. Jandaghian, Z.; Berardi, U. Analysis of the cooling effects of higher albedo surfaces during heat waves coupling the weather research and forecasting model with building energy models. *Energy Build.* **2019**, *207*, 109627. [CrossRef]
86. Chen, D.; Wang, X.; Thatcher, M.; Barnett, G.; Kachenko, A.; Prince, R. Urban vegetation for reducing heat related mortality. *Environ. Pollut.* **2014**, *192*, 275–284. [CrossRef] [PubMed]
87. Tzoulas, K.; Korpela, K.; Venn, S.; Yli-Pelkonen, V.; Kaźmierczak, A.; Niemela, J.; James, P. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landsc. Urban Plan.* **2007**, *81*, 167–178. [CrossRef]
88. Thevathasan, N.V.; Gordon, A.M. Ecology of tree intercropping systems in the North temperate region: Experiences from southern Ontario, Canada. *New Vistas Agrofor.* **2004**, *1*, 257–268. [CrossRef]
89. Francis, R. Wall ecology: A frontier for urban biodiversity and ecological engineering. *Prog. Phys. Geogr. Earth Environ.* **2010**, *35*, 43–63. [CrossRef]
90. Tonietto, R.; Fant, J.; Ascher, J.; Ellis, K.; Larkin, D. A comparison of bee communities of Chicago green roofs, parks and prairies. *Landsc. Urban Plan.* **2011**, *103*, 102–108. [CrossRef]
91. Thevathasan, N.V. Agroforestry research and development in Canada: The way forward in agroforestry. In *The Future of Global Land Use*; Advances in Agroforestry; Springer: Berlin/Heidelberg, Germany, 2012; Volume 9. [CrossRef]
92. Wotherspoon, A.; Thevathasan, N.V.; Gordon, A.M.; Voroney, R.P. Carbon sequestration potential of five tree species in a 25-year-old temperate tree-based intercropping system in southern Ontario, Canada. *Agrofor. Syst.* **2014**, *88*, 631–643. [CrossRef]
93. Coutts, C.; Hahn, M. Green Infrastructure, Ecosystem Services, and Human Health. *Int. J. Environ. Res. Public Health* **2015**, *12*, 9768–9798. [CrossRef]
94. Azunre, G.A.; Amponsah, O.; Peprah, C.; Takyi, S.A.; Braimah, I. A review of the role of urban agriculture in the sustainable city discourse. *Cities* **2019**, *93*, 104–119. [CrossRef]
95. Parkins, K.; Clark, J. Green roofs provide habitat for urban bats. *Glob. Ecol. Conserv.* **2015**, *4*, 349–357. [CrossRef]

96. Anderson, V.; Gough, W.; Agic, B. Nature-Based Equity: An Assessment of the Public Health Impacts of Green Infrastructure in Ontario Canada. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5763. [CrossRef] [PubMed]
97. Thornbush, M.J. *Vehicular Air Pollution and Urban Sustainability: An Assessment from Central*; Springer Briefs in Geography; Springer: Oxford, UK, 2015.
98. Thornbush, M. Urban agriculture in the transition to low carbon cities through urban greening. *AIMS Environ. Sci.* **2015**, *2*, 852–867. [CrossRef]
99. Voskamp, I.M.; Van de Ven, F.H.M. Planning support system for climate change: Composing effective sets of blue-green measures to reduce urban vulnerability to extreme weather events. *Build. Environ.* **2014**, *83*, 159–167. [CrossRef]
100. Soussana, J.; Tallec, T.; Blanfort, V. Mitigating the greenhouse gas balance of ruminant production systems through carbon sequestration in grasslands. *Animal* **2010**, *4*, 334–350. [CrossRef]
101. USDA. Riparian Forest Buffers. Available online: https://www.fs.usda.gov/nac/practices/riparian-forest-buffers.php (accessed on 1 May 2022).
102. U.S. EPA. Functions and Values of Wetlands. Fact Sheet. Available online: https://www.epa.gov/sites/default/files/2021-01/documents/functions_values_of_wetlands.pdf (accessed on 1 May 2022).
103. Dahl, T.E.; Stedman, S.M. Status and Trends of Wetlands in the Coastal Watersheds of the Conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 2013. Available online: https://www.fws.gov/wetlands/Documents/Status-and-Trends-of-Wetlands-In-the-Coastal-Watersheds-of-the-Conterminous-US-2004-to-2009.pdf (accessed on 1 May 2022).
104. Li, X.; Bellerby, R.; Craft, C.; Widney, S.E. Coastal wetland loss, consequences, and challenges for restoration. *Anthr. Coasts* **2018**, *1*, 1–15. [CrossRef]
105. US. EPA. Classification and Types of Wetlands. Available online: https://www.epa.gov/wetlands/classification-and-types-wetlands#undefined (accessed on 1 May 2022).
106. Plascencia-Escalante, F. An Analysis of some Components of the Nitrogen Cycle as Affected by Land Use Adjacent to the Riparian Zone of a Southern Ontario Stream. Ph.D. Thesis, University of Guelph, Guelph, ON, Canada, 2008.
107. US. EPA. Constructed Treatment Wetlands. Factsheet. Available online: https://nepis.epa.gov/Exe/ZyPDF.cgi/30005UPS.PDF?Dockey=30005UPS.PDF (accessed on 1 May 2022).
108. USDA. Working Tree: What Is a Riparian Forest Buffer? 2012. Available online: https://www.fs.usda.gov/nac/assets/documents/workingtrees/infosheets/rb_info_050712v3.pdf (accessed on 1 May 2022).
109. Dropkin, E.M.; Bassuk, N.; Signorelli, S. *Woody Shrubs for Stormwater Retention Practices*, 2nd ed.; Cornell University: Ithaca, NY, USA, 2017; Available online: http://www.hort.cornell.edu/uhi/outreach/pdfs/woody_shrubs_stormwater_hi_res.pdf (accessed on 1 May 2022).
110. Mitsch, W.J.; Gosselink, J.G. *Wetlands*, 5th ed.; John Wiley & Sons: Hoboken, NJ, USA, 2015.
111. Devito, K.J.; Hokanson, K.; Moore, P.A.; Kettridge, N.; Anderson, A.; Chasmer, L.; Hopkinson, C.; Lukenbach, M.C.; Mendoza, C.A.; Morissette, J.; et al. Landscape controls on long-term runoff in subhumid heterogeneous Boreal Plains catchments. *Hydrol. Process.* **2017**, *31*, 2737–2751. [CrossRef]
112. Sheweka, S.M.; Mohamed, N.M. Green facades as a new sustainable approach towards climate change. *Energy Procedia* **2012**, *18*, 507–520. [CrossRef]
113. Hoelscher, M.T.; Nehls, T.; Jänicke, B.; Wessolek, G. Quantifying cooling effects of façade greening: Shading, transpiration and insulation. *Energy Build.* **2016**, *114*, 283–290. [CrossRef]
114. Anderson, V.; Gough, W. Harnessing the Four Horsemen of Climate Change: A Framework for Deep Resilience, Decarbonization, and Planetary Health in Ontario, Canada. *Sustainability* **2021**, *13*, 379. [CrossRef]
115. Hillel, D.; Rosenzweig, C. Biodiversity and food production. In *Sustaining Life: How Human Health Depends on Biodiversity*; Chivian, E., Bernstein, A., Eds.; Oxford University Press: New York, NY, USA, 2008; pp. 325–381.
116. Whittinghill, L.J.; Rowe, D.B.; Schutzki, R.; Cregg, B.M. Quantifying carbon sequestration of various green roof and ornamental landscape systems. *Landsc. Urban Plan.* **2014**, *123*, 41–48. [CrossRef]
117. Montagnini, F.; Nair, P.K.R. Carbon sequestration: An underexploited environmental benefit of agroforestry systems. In *Advances in Agroforestry*; Springer: Berlin/Heidelberg, Germany, 2004; pp. 281–295. [CrossRef]
118. Peichl, M.; Thevathasan, N.V.; Gordon, A.M.; Huss, J.; Abohassan, R.A. Carbon Sequestration Potentials in Temperate Tree-Based Intercropping Systems, Southern Ontario, Canada. *Agrofor. Syst.* **2006**, *66*, 243–257. [CrossRef]
119. Howard, J.; Sutton-Grier, A.; Herr, D.; Kleypas, J.; Landis, E.; Mcleod, E.; Simpson, S. Clarifying the role of coastal and marine systems in climate mitigation. *Front. Ecol. Environ.* **2017**, *15*, 42–50. [CrossRef]
120. NOAA. Protecting Coastal Blue Carbon Through Habitat Conservation. 2022. Available online: https://www.fisheries.noaa.gov/national/habitat-conservation/protecting-coastal-blue-carbon-through-habitat-conservation (accessed on 1 May 2022).
121. Schuman, G.; Janzen, H.; Herrick, J. Soil carbon dynamics and potential carbon sequestration by rangelands. *Environ. Pollut.* **2002**, *116*, 391–396. [CrossRef]
122. Jones, M.B.; Donnelly, A. Carbon sequestration in temperate grassland ecosystems and the influence of management, climate and elevated CO_2. *New Phytol.* **2004**, *164*, 423–439. [CrossRef]
123. Wang, X.; VandenBygaart, A.; McConkey, B.C. Land Management History of Canadian Grasslands and the Impact on Soil Carbon Storage. *Rangel. Ecol. Manag.* **2014**, *67*, 333–343. [CrossRef]

124. Soussana, J.F.; Loiseau, P.; Vuichard, N.; Ceschia, E.; Balesdent, J.; Chevallier, T.; Arrouays, D. Carbon cycling and sequestration opportunities in temperate grasslands. *Soil Use Manag.* **2004**, *20*, 219–230. [CrossRef]
125. Carter, V. Technical Aspects of Wetlands: Wetland Hydrology, Water Quality, and Associated Functions. In *United States Geological Survey Water Supply Paper 2425*; United States Geological Survey: Reston, VA, USA, 1997.
126. Costanza, R.O.; Pérez-Maqueo, M.L.; Martinez, P.; Sutton, S.J.; Anderson, K.M. The value of coastal wetlands for hurricane protection. *Ambio* **2008**, *37*, 241–248. [CrossRef]
127. Dalton, J.; Murti, R. Utilizing Integrated Water Resource Management Approaches to Support Disaster Risk Reduction. In *The Role of Ecosystems in Disaster Risk Reduction*; Sudmeier-Rieux, K., Estrella, M., Eds.; United Nations University Press: Bonn, Germany, 2013.
128. Smith, M. Water for Nature, Nature for Water. In *The Post 2015 Water Thematic Consultation-Water Resources Management Stream Framing Paper*; IUCN: Gland, Switzerland, 2013.
129. Ozment, S.; DiFrancesco, K.; Gartner, T. The role of natural infrastructure in the water, energy and food nexus. In *Nexus Dialogue Synthesis Papers*; IUCN: Gland, Switzerland, 2015.
130. Martin, D.M.; Morton, T.; Dobrzynski, T.; Valentine, B. Estuaries on the Edge: The Vital Link Between Land and Sea. In A Report by American Oceans Campaign. 1996. Available online: https://tamug-ir.tdl.org/handle/1969.3/27595 (accessed on 6 July 2022).
131. Colgan, C.S.; Yakovleff, D.; Merrill, S.B. An Assessment of the Economics of Natural and Built Infrastructure for Water Resources in Maine. 2013. Available online: http://muskie.usm.maine.edu/Publications/AssessmentWaterResourcesMaine.pdf (accessed on 1 May 2022).
132. Parkyn, S. *Review of Riparian Buffer Zone Effectiveness*. Maf Technical Paper No: 2004/05. 2004. Available online: https://www.researchgate.net/publication/250179940_Review_of_Riparian_Buffer_Zone_Effectiveness (accessed on 6 July 2022).
133. Davies, P.M.; Bunn, S.E.; Hamilton, S.K. Primary Production in Tropical Streams and Rivers. In *Aquatic Ecology, Tropical Stream Ecology*; David, D., Ed.; Academic Press: Cambridge, MA, USA, 2008; pp. 23–42. ISBN 9780120884490. [CrossRef]
134. Whitehead, P.G.; Wilby, R.L.; Battarbee, R.W.; Kernan, M.; Wade, A.J. A review of the potential impacts of climate change on surface water quality. *Hydrol. Sci. J.* **2009**, *54*, 101–123. [CrossRef]
135. Whittinghill, L.J.; Rowe, D.B.; Andresen, J.A.; Cregg, B.M. Comparison of stormwater runoff from sedum, native prairie, and vegetable producing green roofs. *Urban Ecosyst.* **2014**, *18*, 13–29. [CrossRef]
136. de la Cretaz, A.L.; Barten, P.K. *Land Use Effects on Streamflow and Water Quality in the Northeastern United States*; CRC Press: Boca Raton, FL, USA, 2007. [CrossRef]
137. Enanga, E.M.; Shivoga, W.A.; Maina-Gichaba, C.; Creed, I.F. Observing Changes in Riparian Buffer Strip Soil Properties Related to Land Use Activities in the River Njoro Watershed, Kenya. *Water Air Soil Pollut.* **2010**, *218*, 587–601. [CrossRef]
138. Schmidt, R.; Batker, D. *Nature's Value in the Mckenzie Watershed: A Rapid Ecosystem Service Valuation*; Earth Economics and Eugene Water and Electric Board: Tacoma, WA, USA, 2012.
139. Mazzotta, M.; Bousquin, J.; Berry, W.; Ojo, C.; McKinney, R.; Hyckha, K.; Druschke, C.G. Evaluating the ecosystem services and benefits of wetland restoration by use of the rapid benefit indicators approach. *Integr. Environ. Assess. Manag.* **2018**, *15*, 148–159. [CrossRef] [PubMed]
140. Shahjahan, A.; Ahmed, K.; Said, I. Study on Riparian Shading Envelope for Wetlands to Create Desirable Urban Bioclimates. *Atmosphere* **2020**, *11*, 1348. [CrossRef]
141. Xu, X.; Chen, M.; Yang, G.; Jiang, B.; Zhang, J. Wetland ecosystem services research: A critical review. *Glob. Ecol. Conserv.* **2020**, *22*, e01027. [CrossRef]
142. Alikhani, S.; Nummi, P.; Ojala, A. Urban Wetlands: A Review on Ecological and Cultural Values. *Water* **2021**, *13*, 3301. [CrossRef]
143. Stevens, C.J. Recent advances in understanding grasslands. *F1000Research* **2018**, *7*, 1363. [CrossRef] [PubMed]
144. Bengtsson, J.; Bullock, J.M.; Egoh, B.; Everson, C.; Everson, T.; O'Connor, T.; O'Farrell, P.J.; Smith, H.G.; Lindborg, R. Grasslands-more important for ecosystem services than you might think. *Ecosphere* **2019**, *10*, e02582. [CrossRef]
145. Zhao, Y.; Liu, Z.; Wu, J. Grassland ecosystem services: A systematic review of research advances and future directions. *Landsc. Ecol.* **2020**, *35*, 793–814. [CrossRef]
146. Paudel, S.; Cobb, A.B.; Boughton, E.H.; Spiegal, S.; Boughton, R.K.; Silveira, M.L.; Swain, H.M.; Reuter, R.; Goodman, L.E.; Steiner, J.L. A framework for sustainable management of ecosystem services and disservices in perennial grassland agroecosystems. *Ecosphere* **2021**, *12*, e03837. [CrossRef]
147. Nowak, D.J.; Wang, J.; Endreny, T. Environmental and Economic Benefits of Preserving Forests within Urban Areas: Air and Water. In *The Economic Benefits of Land Conservation*; De Brun, C.T.F., Ed.; The Trust for Public Land: Los Angeles, CA, USA, 2007; Chapter 4; pp. 28–47.
148. Karjalainen, E.; Sarjala, T.; Raitio, H. Promoting human health through forests: Overview and major challenges. *Environ. Heal. Prev. Med.* **2009**, *15*, 1–8. [CrossRef]
149. Macura, B.; Secco, L.; Pullin, A.S. Does the effectiveness of forest protected areas differ conditionally on their type of governance? *Environ. Évid.* **2013**, *2*, 14. [CrossRef]
150. Michel, A.; Seidling, W. Forest Condition in Europe: 2016 Technical Report of ICP Forests: Report under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). 2016. Available online: https://www.icp-forests.org/pdf/TR2016.pdf (accessed on 6 July 2022).

151. Scullion, J.J.; Vogt, K.A.; Drahota, B.; Winkler-Schor, S.; Lyons, M. Conserving the Last Great Forests: A Meta-Analysis Review of the Drivers of Intact Forest Loss and the Strategies and Policies to Save Them. *Front. For. Glob. Chang.* **2019**, *2*, 62. [CrossRef]
152. Ulrich, R.S. View through a window may influence recovery from surgery. *Science* **1984**, *224*, 420–421. [CrossRef]
153. Crouse, D.L.; Pinault, L.; Balram, A.; Hystad, P.; Peters, P.A.; Chen, H.; van Donkelaar, A.; Martin, R.V.; Ménard, R.; Robichaud, A.; et al. Urban greenness and mortality in Canada's largest cities: A national cohort study. *Lancet Planet. Health* **2017**, *1*, e289–e297. [CrossRef]
154. James, P.; Hart, J.E.; Banay, R.F.; Laden, F. Exposure to Greenness and Mortality in a Nationwide Prospective Cohort Study of Women. *Environ. Health Perspect.* **2016**, *124*, 1344–1352. [CrossRef] [PubMed]
155. Vienneau, D.; de Hoogh, K.; Faeh, D.; Kaufmann, M.; Wunderli, J.M.; Röösli, M.; SNC Study Group. More than clean air and tranquillity: Residential green is independently associated with decreasing mortality. *Environ. Int.* **2017**, *108*, 176–184. [CrossRef] [PubMed]
156. Villeneuve, P.J.; Jerrett, M.; Su, J.G.; Burnett, R.T.; Chen, H.; Wheeler, A.J.; Goldberg, M.S. A cohort study relating urban green space with mortality in Ontario, Canada. *Environ. Res.* **2012**, *115*, 51–58. [CrossRef] [PubMed]
157. Lee, J.; Tsunetsugu, Y.; Takayama, N.; Park, B.-J.; Li, Q.; Song, C.; Komatsu, M.; Ikei, H.; Tyrväinen, L.; Kagawa, T.; et al. Influence of Forest Therapy on Cardiovascular Relaxation in Young Adults. *Evid. Based Complement. Altern. Med.* **2014**, *2014*, 834360. [CrossRef]
158. Song, C.; Ikei, H.; Miyazaki, Y. Physiological Effects of Nature Therapy: A Review of the Research in Japan. *Int. J. Environ. Res. Public Health* **2016**, *13*, 781. [CrossRef]
159. Jo, H.; Song, C.; Miyazaki, Y. Physiological Benefits of Viewing Nature: A Systematic Review of Indoor Experiments. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4739. [CrossRef] [PubMed]
160. Defries, R.S.; Foley, J.; Asner, G. Land-use choices: Balancing human needs and ecosystem function. *Front. Ecol. Environ.* **2004**, *2*, 249–257. [CrossRef]
161. Goldberg, T.L.; Gillespie, T.R.; Rwego, I.B.; Estoff, E.L.; Chapman, C.A. Forest Fragmentation as Cause of Bacterial Transmission among Nonhuman Primates, Humans, and Livestock, Uganda. *Emerg. Infect. Dis.* **2008**, *14*, 1375–1382. [CrossRef] [PubMed]
162. Ostfeld, R.S.; Keesing, F.; Eviner, V. *Infectious Disease Ecology: Effects of Ecosystems on Disease and of Disease on Ecosystems*; Princeton University Press: Princeton, NJ, USA, 2008.
163. Gottdenker, N.L.; Streicker, D.; Faust, C.L.; Carroll, C.R. Anthropogenic Land Use Change and Infectious Diseases: A Review of the Evidence. *EcoHealth* **2014**, *11*, 619–632. [CrossRef] [PubMed]
164. Warwick, F.; Charlesworth, S. Sustainable drainage devices for carbon mitigation. *Manag. Environ. Qual. Int. J.* **2012**, *24*, 123–136. [CrossRef]
165. Government of Canada. Healthy Environment and a Healthy Economy. 2021. Available online: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf (accessed on 15 June 2022).
166. Revi, A.; Satterthwaite, D.E.; Aragón-Durand, F.; Corfee-Morlot, J.; Kiunsi, R.B.R.; Pelling, M.; Roberts, D.C.; Solecki, W. Urban areas. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014; pp. 535–612.
167. Smith, K.R.; Woodward, A.; Campbell-Lendrum, D.A.; Chadee, D.D.; Honda, Y.; Liu, Q.; Olwoch, J.M.; Revich, B.; Sauerborn, R. Human health: Impacts, adaptation, and co-benefits. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*; Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014; pp. 709–754.
168. URBES. Green Infrastructure, a Wealth for Cities. Fact Sheet. 2014. Available online: https://www.iucn.org/sites/dev/files/import/downloads/urbes_factsheet_06_web.pdf (accessed on 25 June 2022).
169. European Commission. Green Infrastructure (GI)—Enhancing Europe's Natural Capital. 2013. Available online: https://eur-lex.europa.eu/resource.html?uri=cellar:d41348f2-01d5-4abe-b817-4c73e6f1b2df.0014.04/DOC_1&format=PDF (accessed on 25 June 2022).