

# FOREST RELATED NATURE-BASED APPROACHES

## Review of terms and concepts – from afforestation to forest landscape restoration

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**INTEGRATED SOLUTION**  
**LAND(SCAPE) RESTORATION**  
**FOREST LANDSCAPE**  
**MANAGEMENT**  
**NATURE-BASED ECOSYSTEM-BASED**  
**AFFORESTATION**  
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## ABBREVIATIONS, ACRONYMS

<b>AFF</b>	Afforestation
<b>BMUV</b>	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection of Germany
<b>CBD</b>	Convention on Biological Diversity
<b>COVID-19</b>	Coronavirus disease
<b>DOI</b>	Digital Object Identifier
<b>EBA</b>	Ecosystem-based Adaptation
<b>EU</b>	European Union
<b>FAO</b>	Food and Agriculture Organization
<b>FLR</b>	Forest Landscape Restoration
<b>FR</b>	Forest Restoration
<b>ILM</b>	Integrated Land(scape) Management
<b>IUCN</b>	International Union for the Conservation of Nature
<b>IUFRO</b>	International Union of Forest Research Organizations
<b>N/A</b>	Non-applicable
<b>NBS</b>	Nature-based Solutions
<b>REW</b>	Rewilding
<b>SDG</b>	Sustainable Development Goal(s)
<b>SER</b>	Society for Ecological Restoration
<b>UNCCD</b>	United Nations Convention to Combat Desertification
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>WoS</b>	Web of Science
<b>WWF</b>	World Wide Fund for Nature / World Wildlife Fund

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# SUMMARY FOR POLICYMAKERS AND PRACTITIONERS

## Objectives of the Study

Many actors globally are attempting to reverse deforestation and forest degradation, combat climate change, and conserve biodiversity, describing their actions with a wide range of often confusing terms. We sought to clarify how seven common terms and concepts are used in the scientific literature, and how to use them more effectively to support forest landscape restoration (FLR) implementation. We examined the definitions, their historical evolution, and past and current applications of the terms and concepts as they related to forest restoration and sustainable forest management.

## Method

We explored a range of terms in the published literature to determine how they have been used, in which research areas they have been used, and how they have changed in importance over time. We used a blended approach for bibliometric analysis and rapid systematic evidence evaluation that had three distinct phases (**Section 2. Methods**):

1. Using a systematic search strategy, 11,165 articles were retrieved from Web of Science and subjected to bibliometric analysis for seven key terms:

- Nature-Based Solution (NBS)
- Ecosystem (Based) Adaptation (EBA)
- Integrated Land(scape) Management (ILM)
- Forest Restoration (FR)
- Forest Landscape Restoration (FLR)
- Afforestation (AFF)
- Rewilding (REW).

2. Ten systematic reviewers recruited from the IUFRO Task Force ‘Transforming Forest Landscapes for Future Climates and Human Well-Being’ extracted partial data from full texts of 700 articles published in 1990 to 2020 (random sets of 100 articles from each of the seven terms), looking for publications that defined the relevant term.

3. The resulting 122 publications that contained definitions were extracted for a full range of data, including scale and location of the study, type of publication, land use context, and focus on sustainability, nature-based concepts, and sustainable development goals.

## Key Findings

We observed definite temporal and geographic trends in usage of nature-based concepts in the scientific literature allowing for a synoptic interpretation of the seven key terms:

- Usage over time (**Section 3.2.3 The use of nature-based terms across time**): There was a trend toward more integrative, broader scale approaches (i.e., landscapes) with the early emergence of ILM that has been eclipsed by EBA and NBS. The terms AFF and FR appeared first in the literature, AFF in 1903 and FR in the 1970s; ILM and EBA almost two decades later in 1992; less than a decade later REW (1999), followed by FLR in 2002; and NBS another decade later (2009). Most publications containing definitions referred to authoritative standards, rather than offering the authors' definitions, however, various sources were cited.
- Geographic trends (**Section 3.2.4 The use of nature-based terms across space**): Forests and rural land uses dominated the context of publications except for NBS, which emerged primarily from an urban/city context. There was a clear geographic divide: FLR publications dominantly arose from the global South while the other terms came either from the global North or from the economically developed countries plus emerging economies in Africa, Asia, and South America.
- Usage in thematic fields (**Section 3.3 Use of nature-based terms by different disciplines through time**): Forest Landscape Restoration (FLR) was most prominent in forestry journals and to a lesser extent in agriculture journals and barely detectable in the other journals. Of all the terms, FLR was the most cognizant of sustainability concepts.

Synopsis of broader concepts: Nature-based approaches could be a useful umbrella concept for restoring and sustainably managing socio-ecological systems. The term NBS, however, in urban contexts has embraced engineered solutions, in addition to approaches that use or mimic natural systems to replace structural engineering solutions. Although FLR has been intimately connected to the Bonn Challenge, other integrated landscape initiatives, such as EBA and ILM are useful to account for the interconnectedness of landscape elements. EBA does not directly lead to restoration of forest landscapes, though the concept includes important co-benefits. Importantly, EBA is a concept that can be used without bias in terms of geography, land use, or scale. Nevertheless, FLR has the distinct advantage of explicitly engaging the highly diverse actors that have a stake in the landscapes targeted for restoration. In addition, FLR has a super-national connotation, which implies the usefulness of the concept for reviewing restoration efforts at scales.

Older concepts such as AFF and FR remain useful in distinct land use types to contribute towards ambitious restoration targets. AFF can be appropriate for converting non-forest to

forest land on a large scale or in landscapes of uniform land use, where interconnectedness with other landscape elements plays a subordinate role. Similarly, FR is suitable in degraded forested landscapes. Rewilding has been limited to countries of the global North, however, defaunation has negatively affected forest regeneration worldwide and this concept may have broader relevance in FLR, depending on context.

## Conclusions

The meaning of words can be transient, changing over time by taking on new meanings and incorporating older meanings. Languages evolve and words can become plastic, obscuring nuance and replacing precision with vague, even contradictory ‘buzz words.’ Nature-based concepts have been embraced by different scientific disciplines and operationalized by practitioners in different ecological, social and historic contexts. Rewilding and Forest Landscape Restoration originated in the academic world and were embraced by policy organizations and popularized by NGOs; other terms, such as Ecosystem-Based Adaptation and Nature-Based Solutions, followed the opposite path, from the policy vernacular to the scientific.

Words are mutable, changing over time. World views, value systems, and simply ecological context and professional experience shape word meaning and usage. For example, natural, native, wild, and wilderness; the common sense understanding of these words are imprecise and often encompass contradictory meanings. But when terms enter the popular vernacular, they can become vague or ‘plastic’ and loaded with added meaning. Sometimes this is done to accommodate organizational or policy goals, for example the evolution of FLR (removal of ‘planned process’, addition of ‘and’ to forest and landscape restoration). Science strives for precision of expression, and this can lead to obtuse jargon. Scientific terms change meaning, however, as added information and understanding develop. Policies and popular understanding based on older scientific understanding become obsolete and maladaptive. To communicate clearly to non-technical audiences, it may be necessary to simplify messages, but this must be done carefully, with sufficient explanation to avoid confusion.

## Recommendations for policymakers and practitioners

Adherence to a specific definition of a nature-based approach is less important than emphasizing expected outcomes in terms of improving the quality of the targeted socio-ecological system. Following the principles and standards of nature-based approaches should improve the amount and quality (composition and structure) of vegetation cover, secure ecosystem services of clean water in quantity, soil and biodiversity protection, and production of products from the forest (harvested wood

volumes or non-timber forest products, food security), and improve livelihoods in terms of income levels, improvements, and jobs.

- Funding agencies are recommended to require from grant applicants a clear definition of terms that are used in their grant applications to ensure that the concept as used by applicants is clearly understood. Where possible, applicants should reference authoritative definitions.
- Applications can be screened for the use of nature-based terms in various sections of the documents. This will help to identify whether key terms are used as mere buzz words to attract attention, or whether the concepts behind them truly determine the approach taken by applicants.
- Well-defined terms set the context for proposed actions but for securing desired outcomes, principles and concepts are more important than terms. Thus, proposals should not be judged by their use (or even misuse) of terms, but by ensuring that principles and standards are met, and proposed actions clearly relate to the intended outcomes.
- Beyond a mere definition, grant applicants should be required to describe their proposed interventions in the context of any applicable principles or standards that potentially exist and are commonly accepted under the concerned nature-based terms.
- In addition to explaining how the proposed activity adheres to recognized principles and standards, project proponents should explain how their proposed activities will lead to intended outcomes. Outcomes should be assessed through adequate monitoring and evaluation systems.
- Beyond simply checking boxes of compliance with applicable principles and standards, proposals should be investigated to see if the concepts defined by the respective nature-based term(s) as well as the principles and standards form integral parts of the theories-of-change of the proposed intervention. If applications are required to include theory-of-change graphical presentations, logical frameworks, including indicators, or other project management frameworks, adherence to applicable principles and standards should be reflected throughout these planning tools.
- Terms that include a social process (intervention into social-ecological systems) are more valuable in delivering forest-related restoration targets than terms that only cover technical approaches (intervention into ecological systems alone).
- Terms evolve over time and as these nature-based concepts become embedded in policies and programs – usually involving considerable funding – they take on contractual meaning. Thus, it will be important to periodically assess the use of nature-based terms, their definitions, and the concepts embedded within.
- Policymakers and practitioners are advised to keep in mind the strongly regional

(e.g., ‘Forest Restoration’, ‘Integrated Landscape Management’), land use-specific (e.g., ‘Nature-Based Solutions’), or scale-specific (e.g., ‘Integrated Landscape Management’) connotation of certain nature-based terms.

Maintaining the momentum for restoring forested landscapes will be a challenge going forward as the UN Decade on Ecosystem Restoration focuses attention on other ecological systems badly in need of restoration. As a process, FLR has demonstrated the strength of involving many stakeholders in balancing ecological functioning with social benefits and livelihoods. This is apparent as other nature-based processes have incorporated inclusive, participatory planning. Rather than compromising between competing initiatives, the global community could begin a dialogue on harmonizing nature-based concepts and developing universally applicable guiding principles and standards that balance ecological functioning and social development.



# 1. INTRODUCTION

## 1.1 Background

Landscapes dominated by forests are often embedded with other land uses and contribute to achieving many Sustainable Development Goals (SDGs) by providing multiple ecosystem services essential to society. These include provisioning, regulating, supporting, and cultural services (IPBES, 2019). Especially for rural populations, forest landscapes are often the basis for the local economy and social identity. However, forest landscapes are under pressure from the loss and degradation of forest area and conversion to other land uses, as well as environmental and climate change (Curtis et al., 2018). As a result, societies worldwide may face diminishing levels of ecosystem services from forest landscapes with negative effects on livelihoods and wellbeing (Carrasco et al., 2017; Foley et al., 2007). Therefore, combined strategies for forest landscape preservation, restoration, and adaptive management are needed to prevent significant losses of forest landscape ecosystems and their benefits.

Efforts at multiple scales by a myriad of actors attempt to reverse these trends of deforestation and forest degradation, leading to use of many terms in confusing ways in the Forest Landscape Restoration (FLR) literature (Mansourian, 2018; Stanturf, Palik, Williams, et al., 2014) and elsewhere. Our objective is to clarify how a selected group of terms and concepts are used, based on the scientific literature, and indicate how to utilize these in supporting FLR implementation. Our approach uses standard bibliometric techniques and rapid systematic evidence evaluation in a blended approach. We use forest-related nature-based approaches as the over-arching concept, despite that Nature-Based Solutions (NBS) is a relatively recent term and in some uses includes engineering structural approaches. The term ‘Nature-Based Solution’ may be relatively new, but the concept of managing land for changing climate, biodiversity and sustainability using natural processes is not new in the domain for forest management (broadly ‘forestry’ in this report). We therefore searched in the literature for a suite of terms that we felt were describing similar types of nature-based approaches to land management, in addition to the specific term ‘Nature-Based Solutions’. Therefore, NBS was one of the specific terms we searched for in the literature.

## 1.2 Study aims and objectives

The terms we examined, in addition to NBS, were Ecosystem (Based) Adaptation (EBA), Integrated Land(scape) Management (ILM), Forest Restoration, Forest Landscape Restoration (FLR), Afforestation, and Rewilding. This study aimed at a scientific synthesis

on forest-related nature-based processes associated with the above-mentioned terms related to the conservation, restoration and sustainable management of forests. Emphasis was placed on collating evidence on the effectiveness of such concepts in restoring degraded landscapes on a large scale and managing such forest landscapes for multiple ecological, social, and economic benefits.

We explored a range of terms to express these concepts in the published literature over time to determine how they relate to each other, how they have been used, in which research areas they have been used, and how they have changed in importance over time. This will contribute to clarity on ‘unpacking’ the concepts in a forestry context and help prevent the creation of terminological ‘silos’ that will be unhelpful in understanding projects, which though using different terminology, have a common aim of providing “*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*” (Colls et al., 2009).

As a significant funder of FLR worldwide, the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV) needs clarification on these different terms and concepts – based on scientific evidence – and thoughts on the way forward for how to utilize these in supporting FLR implementation. Our objective was to clarify the various concepts of forest-related nature-based processes to:

1. Understand how the different terms have been used geographically, through time, and at different scales.
2. Understand how the different terms have been used/defined across disciplines through time.
3. Explore the recognition of sustainability pillars (ecological, social, economic) across the concepts.
4. Explore the recognition of the IUCN Global Standards for Nature-Based Solutions Principles: (i) Societal challenges; (ii) design at scale; (iii) biodiversity conservation; (iv) economic feasibility; (v) inclusive governance; (vi) balance trade-offs; (vii) adaptive management (viii) sustainability.
5. Understand the potential implications of how each of the concepts are implemented at landscape-scale on: (i) tenure; (ii) Indigenous people/communities; (iii) biodiversity; (iv) ecosystem services; (v) wood production; (vi) carbon sequestration and storage.
6. Evaluate the usefulness of the concepts for achieving forest landscape restoration at scale as required by the Bonn Challenge and other global and regional restoration goals.



### 1.3 Definitions

For clarity, we sought standard definitions for the terms we examined, from authoritative global sources, for example FAO, IUCN, UNEP, and the World Bank. Briefly,

**‘Nature-Based Solutions’ (NBS)** is first referenced in the Web of Science in a short news article authored by MacKinnon & Hickey (2009), highlighting the concept outlined in a 2008 World Bank report (MacKinnon et al., 2008). The report does not define ‘Nature-Based solutions,’ but it documents the Bank’s portfolio of projects that support biodiversity and in particular ‘projects and programs that emphasize biodiversity-climate change linkages.’ The specific ecosystems covered by the Bank’s portfolio were forests, mountains, and marine ecosystems, and in addition, protected areas were examined as a theme. Specific projects related to mitigating climate change and the role of biodiversity included those focused on afforestation and reforestation, reducing deforestation, enhanced landscape connectivity and adaptation in agricultural landscapes. Standard – and different – definitions for NBS include:

- *“Nature-based solutions are inspired and supported by nature and simultaneously provide environmental, social, cultural and economic benefits. Nature-based solutions, such as well-connected green and blue infrastructure, green and unsealed surfaces in cities, green roofs, natural water retention measures, and salt marshes and dunes for coastal protection, use the properties and functions of ecosystems to provide water regulation, flood risk protection, climate change adaptation, etc. They are designed to bring more nature and natural features and processes into cities, landscapes and seascapes, through locally adapted and systemic interventions. They are locally attuned, resource efficient, multi-purpose, multi-functional and multi-beneficial.”* (European Commission, 2015).
- NBS are *“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”* (Cohen-Shacham et al., 2016).

**‘Ecosystem-Based Adaptation’ (EBA)** is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people cope with the adverse effects of climate change (Convention on Biological Diversity, 2009).

**‘Integrated Landscape Management’ (ILM)** is *“an umbrella term for natural resource management systems that recognize the value of various ecosystem services to multiple stakeholders, and how this leads them to pursue different land use objectives or livelihood strategies.”* (FAO, 2013). ILM is thus the management of production systems and natural resources in an area large enough to produce vital ecosystem services and small enough to be managed by the people using the land and producing those services (FAO, n.d.). ILM

involves long-term collaboration among diverse groups of land managers and stakeholders to achieve their multiple objectives and expectations within the landscape for local livelihoods, health and well-being (LPFN, 2015).

**'Forest Landscape Restoration'** is *"a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes"* (Mansourian, 2005; WWF & IUCN, 2000). In this context, a forest landscape is *"a landscape that is, or once was, dominated by forests and woodlands and which continues to yield forest-related goods and services"* (Maginnis & Jackson, 2007), while ecological integrity refers to *"maintaining the diversity and quality of ecosystems, and enhancing their capacity to adapt to change and provide for the needs of future generations"* (Mansourian, 2005).

**'Afforestation'** is the *"Establishment of forest through planting and/or deliberate seeding on land that, until then, was under a different land use, implies a transformation of land use from non-forest to forest."* (FAO, 2020).

**'Forest restoration'** lacks an authoritative definition. In broad terms, it is the process of improving the health, productivity, and functioning of a forest. Forest restoration endeavours run the gamut from ecological restoration that strives to recover historical fidelity of species composition and structure to functional approaches that emphasize the restoration of underlying abiotic and biotic processes drive structural and compositional patterns (Stanturf, Palik, Williams, et al., 2014).

**'Rewilding'** is a form of ecological restoration that relies on autonomous biotic and abiotic agents and processes to restore natural conditions. Rewilding may involve creation of an interconnected network of reserves (core areas and corridors) and the reintroduction of missing keystone species (including non-native proxies for extinct species), such as large carnivores and large herbivores (Jørgensen, 2015).

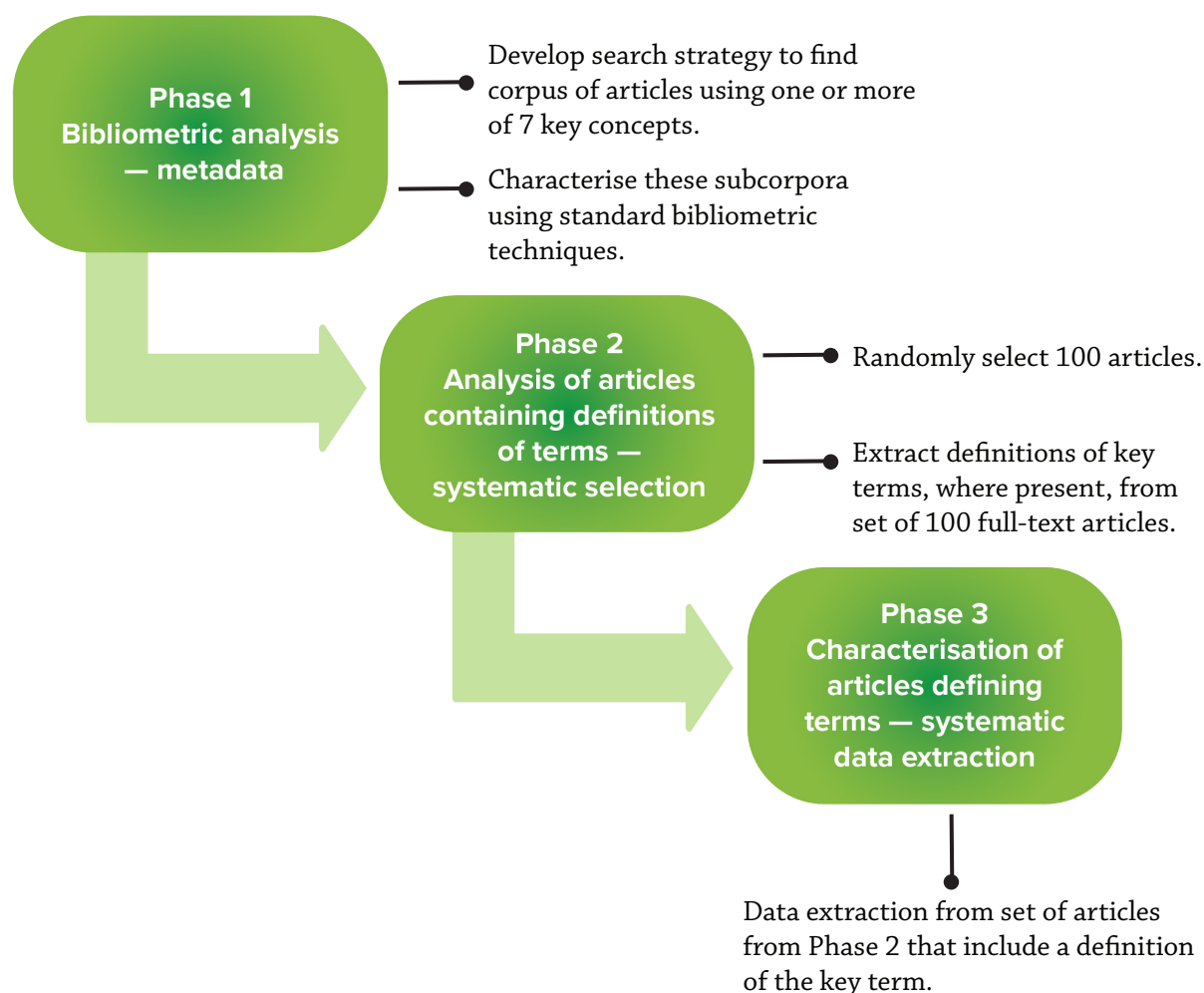


## 2. METHODS

To analyse trends in the literature on forest-related nature-based approaches (including forestry concepts that pre-dated the term NBS), standard techniques used for bibliometric analysis and systematic evidence evaluation were used in a blended approach that had three distinct phases:

1. Bibliometric analysis of articles retrieved from Web of Science using a systematic search strategy for each of seven key concepts (**Table 1**).
2. Selection of random sets of 100 articles from each of the seven subfiles and partial data extraction from full texts of these 100 articles.
3. Full data extraction of articles from phase 2 for which a definition of the key term/ concept was provided in the article.

For phases 2 and 3, the data extraction sheet was agreed upon in an iterative process. **Figure 1** illustrates the three phases.



**Figure 1:** Three phases of the blended method

### 2.1 Search strategy

Building on the World Bank’s original concept of NBS (MacKinnon et al., 2008), a preliminary set of 13 terms (‘Nature-Based Solution’, ‘Proforestation’, ‘Forestation’, ‘Afforestation’, ‘Reafforestation’, ‘Reforestation’, ‘Agroforestation’, ‘Rewilding’, ‘Forest Landscape Restoration’, ‘Ecosystem Restoration’, ‘Ecological Restoration’, ‘Rehabilitation’, and ‘Reclamation’) was reduced to seven terms, eliminating those with very few returns (‘Proforestation’, ‘Reafforestation’ and ‘Agroforestation’) (César et al., 2021), or those considered too broad (‘Ecosystem Restoration’, ‘Ecological Restoration’, ‘Reclamation’, ‘Rehabilitation’, ‘Forestation’, ‘Reforestation’). ‘Ecosystem-based Adaptation’ and ‘Integrated Landscape Management’ were added to the World Bank list because they described integrated approaches to changing land use and since they were required to comply with the NBS principles (Cohen-Shacham et al., 2019, see also Section 4.2). We considered that ‘Ecosystem Restoration’ overlapped with ‘Forest Restoration’, which was our focus and therefore retained the second term. **Table 1** shows the seven terms and the search string used in Web of Science Core Collection.

**Table 1:** Search terms and Boolean string used to search Web of Science [date]

Term	Boolean String
Nature-based solution	ALL FIELDS= (‘Forest restoration’ OR ‘Forest landscape restoration’) OR Afforestation OR Rewilding OR (‘Nature-based solution’ OR ‘nature-based solutions’) OR (‘Ecosystem-based adaptation’ OR ‘Ecosystem adaptation’) OR (‘Integrated landscape management’ OR ‘Integrated land management’)
Forest restoration	
Forest landscape restoration	
Afforestation	
Rewilding	
Ecosystem (based) adaptation	
Integrated land(scape) management	

## 2.2 Phase 1

### 2.2.1 Research domains

Web of Science assigns ‘domains’ to journals and these are replicated in articles published in the journals. To characterise term usage of the seven key terms, six aggregated domains were identified (Table 2).

**Table 2:** Web of Science research areas combined into 6 domains

Domain	Abbreviation
Environmental Sciences & Ecology OR Biodiversity & Conservation	ENV
Forestry	FOR
Agriculture	AGR
Water resources OR Marine & Freshwater Biology OR Fisheries	WAT
Urban studies	URB
Other (all other categories in WoS)	Other

### 2.2.2 Analysis of key term use through time by research domain

Analysis and presentation of data were performed using R package Rioja (Juggins, 2009) in base R (R Development Core Team, 2011). Two separate analyses were undertaken using the same data set comprising 11,165 articles published between 1990-2020.<sup>1</sup> For further analysis data from 1990-2020 were used. All articles contained at least one domain with a total of 12,644 domain tags.

The six WoS domains (environmental, forestry, agriculture, water, urban, and other) were used to group the results returned from the seven search terms (Table 1) and were organised by year of publication. The results are presented (A) as absolute publications by year, indicating an increase or decrease in the amount of published literature; and (B) as a percentage of each year. Constrained hierarchical clustering, following the broken stick model, was conducted on the standardised (percentage) data to identify discrete zones for each search term. Results are presented under the six domain groupings subdivided by the seven search terms.

<sup>1</sup> “Afforestation” first appears in a record from 1903. However, less than 1.5% of records were published between this time and 1990.

### 2.2.3 Term use by journal

To assess trends in terminology over time in different journals, we tracked the percentage of the top 20 journals' contribution to the subset of records containing the term 'Nature-Based Solution(s)'. The top 20 were defined as the 20 most frequently occurring journals in which NBS articles were published. The results for NBS showed little or nothing of interest and we did not pursue this analysis for the other terms.

## 2.3 Phases 2 and 3

Building on the data extraction method of Hanson et al. (2020), the 11,165 articles found in Phase 1 were categorised in two phases. In a departure from normal systematic review practice, owing to resource limitations, articles were not screened sequentially at Title, Abstract and Full-text stages using inclusion criteria. Instead, a random selection of articles was taken from the set retrieved from Web of Science and inclusion criteria were applied to these. Data extraction proceeded in two phases. The inclusion criteria for each phase were:

- Phase 2: The article must include use of at least one of the seven key terms and must include a definition of the key term.
- Phase 3: The article must have been assessed at Phase 2 for presence of a definition of the key term.

### 2.3.1 Full-text acquisition

A random number generator was used to select 100 articles for each of the seven search terms from the WoS search and constrained by articles with a DOI. These 700 publications were located, and pdf files downloaded into a shared folder for further analysis. The complete list of sampled publications is available on request.

### 2.3.2 Full-text data extraction Phase 2 and 3

Ten systematic reviewers recruited from the IUFRO Task Force 'Transforming Forest Landscapes for Future Climates and Human Well-Being' (*IUFRO: Task Force Members and Expertise / Transforming Forest Landscapes for Future Climates and Human Well-Being / Task Forces*, n.d.) were assigned 70 full-text articles from the set of 700 articles for data extraction. Metadata for included articles were drawn from Phase 1. Articles that had a definition of the key term of interest were selected from the 70 for further examination (for example, the term 'forest restoration' had to be defined if the article was from the set 'Forest Restoration'). In phase 3, the ten reviewers assessed the information from Phase 2 and extracted additional information (**Table 3**) from each article. Finally, two authors who were not of the 10 reviewers validated and consolidated the database and performed the analysis. The extraction sheet for all phases is shown in **Table 3**.

**Table 3:** Data extraction sheet with descriptions and Phase of data collection.

Review Topics	Description	Data Extraction	Extraction Phase
Article ID	Unique article ID	Metadata	1
Concept Group	Concept	Metadata	1
Reference Type	Type of reference	Metadata	1
Publication Year	Year of publication	Metadata	1
Author(s)	List of authors(s)	Metadata	1
Author(s) Institution	List of author(s) institution(s)	Metadata	1
Title	Article title	Metadata	1
Journal / Secondary Title	Journal title	Metadata	1
DOI	DOI	Metadata	1
Abstract	Abstract text	Metadata	1
Volume	Journal volume	Metadata	1
Issue	Journal issue	Metadata	1
Pages	Journal pages	Metadata	1
Funder	Funding information	Metadata	1
Language	Language of article	Metadata	1
WoS Domain	Web of Science Domain	Metadata	1



Review Topics	Description	Data Extraction	Extraction Phase
Is the Nature-Based Concept Defined? (Y/N)	Does the article define the nature-based concept?	Coder	2
Multiple Definitions of Concept (Y/N)	Are there multiple definitions of the nature-based concept?	Coder	2
Definition(s) of Concept (text)	Text from article defining nature-based concept	Coder	2
Source(s) of Definition	Source of definition of nature-based concept	Coder	2
How Many Times is the Concept Mentioned in the Paper? (Including acronyms)	Number of times the nature-based concept is mentioned in the article (including acronyms)	Coder	2
Other Related Green Concepts	Mention of other green related concepts	Coder	2
Global (Y/N)	The nature-based term applies globally	Coder	2
Continent	The nature-based term applies to (a) continent(s)	Coder	2
Country	The nature-based term applies to a country	Coder	2
LatDD of study	Latitude of Study (decimal degrees)	Coder	2
LonDD of study	Longitude of Study (decimal degrees)	Coder	2
Study type	Type of study	Coder	3
Focus of Sustainability Pillars	The article refers to a pillar of sustainability	Coder	3
Focus of IUCN Global Standard for Nature-based Solutions Principles	The article refers to one or more of the IUCN Global Standard for Nature-Based Solutions Principles.	Coder	3
Sections	Number of times the nature-based term is mentioned in each section of the article (including acronyms).	Coder	3

Review Topics	Description	Data Extraction	Extraction Phase
Source of definition e.g., FAO, Society American Foresters, World Bank, Other etc	Source of definition	Coder	3
Land-use Context	Category of land-use	Coder	3
Sustainable Development Goals	Reference to sustainable development goal(s)	Coder	3
Focus of Sustainability Impact	Mention of how each of the nature-based concepts are implemented at landscape-scale.	Coder	3
Positive/Negative/Mixed Sustainability Impact	Was the impact nature-based concept positive, negative, or mixed?	Coder	3

3

## 3. FINDINGS

### 3.1 Clarification of forest related nature-based terms

#### 3.1.1 Frequency of nature-based terms definitions encountered

The search for definitions in Stage 1 yielded a total of 122 definitions of various terms. Definitions for Ecosystem-based Adaptation (EBA) occurred most frequently (47 times), whereas there were only two definitions for 'Afforestation' (Table 4). Older terms, such as 'Afforestation,' and 'Forest Restoration' were rarely defined, likely, since authors used these terms with an understanding that they were self-explanatory, given their long history of use in the scientific literature. However, even among more recent terms, there was substantial variation in the frequency of definitions encountered. 'Forest Landscape Restoration' (FLR) ranked second, whereas 'Rewilding,' NBS, and 'Integrated Land(scape) Management' (ILM) ranged between 10 and 16 definitions.

**Table 4:** Number of definitions for each search term.

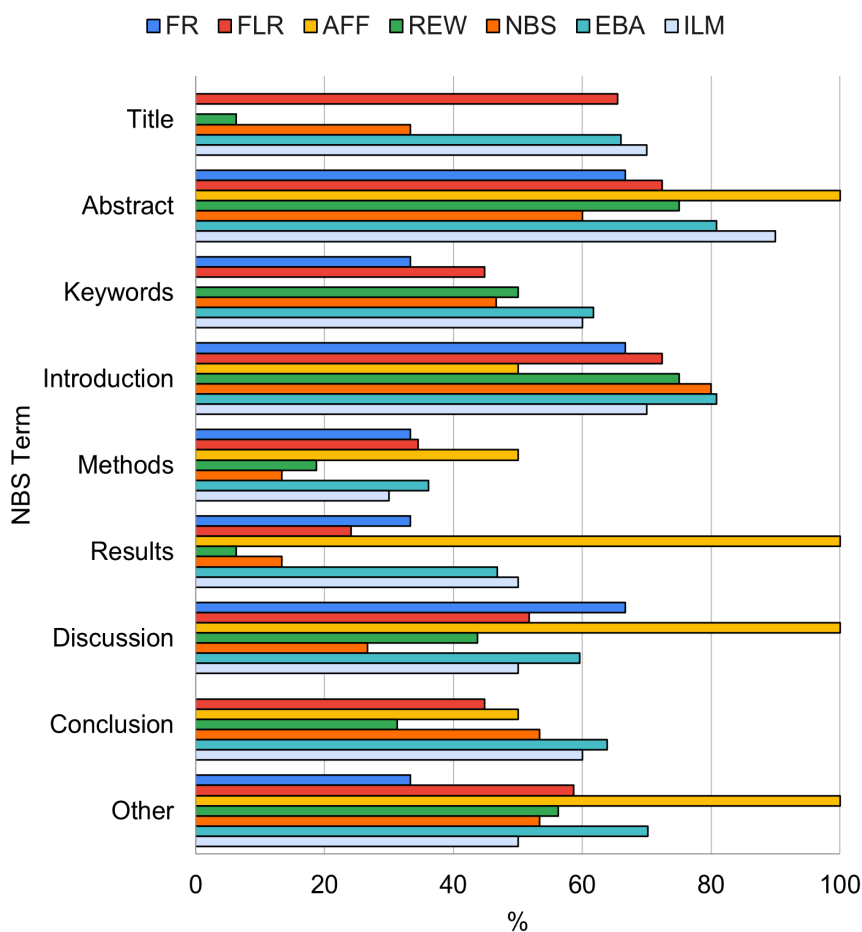
Term	Abbreviation	Number of Definitions
Forest Restoration	FR	3
Forest Landscape Restoration	FLR	29
Afforestation	AFF	2
Rewilding	REW	16
Nature-Based Solution	NBS	15
Ecosystem-Based Adaptation	EBA	47
Integrated Land(scape) Management	ILM	10
	<b>Total</b>	<b>122</b>

### 3.1.2 Use of nature-based terms in different sections of publications

Nature-based terms were mentioned throughout the standard introduction-methods-results-discussion-conclusion sections of scientific publications; however, they were most frequently encountered in the abstract section, followed by the introduction (**Figure 2**). The use of nature-based terms in publication titles was moderately frequent overall, and largely confined to the use of the more recent terms of FLR, EBA, and ILM. In our interpretation, these terms were frequently used by groups of scientists, who have very clear definitions of them, which helps papers to be immediately identified as belonging to a well-delineated technical field.

The overall most common use in abstracts and introduction indicated that various nature-based terms were frequently used to capture attention and were part of the core messages of the sampled publications. ‘Nature-Based Solutions’ was the only term that was not most frequently mentioned in the abstract, but in the introduction instead. This may relate to the use of the term as a context-setter in urban environments. The slightly less frequent use of nature-based terms among the keywords needs to be interpreted in the context of the usually limited number of keywords that any publication has. Therefore, the high frequency of use here indicates the immense importance of these terms as key identifiers, or as buzz words aiming at capturing readers’ attention.

The second most frequent use of nature-based terms in the introduction was explained by the fact that this section helped to put the contents of papers into specific contexts, defined by key technical terms. The mention of nature-based terms was least frequent in the methods and results sections. The discussion and conclusion sections once again applied nature-based terms more frequently, likely in context-specific interpretations of findings and providing recommendations. ‘Other’ sections, including table and figure headings, as well as sections of papers that did not conform to the standard structure, also frequently contained search terms. The terms ‘Afforestation’ and ‘Forest Restoration’ deviated from the general trend in that they were not at all or less frequently used in the titles and keywords and more frequently used in the results and discussion sections, as compared to the remaining terms (**Table 4**). This may relate to the fact that these terms were not identified as fashionable buzz words and that instead the concepts they described were more thoroughly integrated into the contents of the papers in which they occurred.



**Figure 2:** Mention of nature-based term in each section as a percentage of each nature-based term definition. Key: Nature-Based solution (NBS); forest restoration (FR); forest landscape restoration (FLR); afforestation (AFF); rewilding (REW); ecosystem (based) adaptation (EBA); integrated land(scape) management (ILM). ‘Other’ category includes all mentions of NBS approaches in sections such as background section, figure captions, and acknowledgements.

### 3.1.3 Standard definitions for nature-based terms

For each nature-based term, different definitions were used, which however in virtually all cases referenced standard definitions from secondary sources and only in rare cases did they apply author-defined definitions (Table 5). The greatest number of reference sources for defining a given nature-based term was found for ‘Ecosystem-Based Adaptation’ (EBA) with a remarkable 76 and ‘Forest Landscape Restoration’ (FLR) with 62 different source citations. It is likely that the more recent references cited were in fact secondary citations of original definitions, which was, however, not verified through the study. Remarkably, ‘Integrated Landscape Management’ (ILM) emerged as an ill-defined term, mostly set by original definitions of the authors for their own context-specific uses. ‘Afforestation’ and

'Forest Restoration' were defined through very few sources; because definitions for these terms were hardly encountered (**Table 1**), suggesting that although standard definitions exist (refer to **Section 1.3 Definitions**), authors do not feel the need to cite them or are unaware of their existence. FLR, NBS, and EBA emerged as the best-defined nature-based terms with their most accepted sources as WWF & IUCN (2000), European Commission (2015), and Convention on Biological Diversity (2009), respectively. In addition, these terms have been embraced and promoted by international environmental organizations in policy contexts, rather than emerging out of field practice or science.

**Table 5:** Use of standard definitions for each search term.

NBS Term	Most Used Definition Sources	Total Term Definitions
NBS	European Commission (2015)   IUCN (2016)   Cohen-Shacham et al. (2016)	27
EBA	Convention on Biological Diversity (2009)   Author defined   Vignola et al. (2009)   Cohen-Shacham et al. (2016)   Jones et al. (2012)   Brink et al. (2016)   CBD (2008)   Chong (2014)   Colls et al. (2009)   Locatelli et al. (2008)	76
ILM	Author defined   Estrada-Carmona et al. (2014)   Scherr et al. (2013)	17
FLR	WWF & IUCN (2000)   Mansourian (2005)   Lamb et al. (2012)   Maginnis and Jackson (2007)   Maginnis et al. (2007)   The Bonn Challenge (n.d.)   Besseau et al. (2018)	62
AFF	Burns & Nicholson (2017)   Potapov et al. (2015)	2
FR	Bradshaw (1997)   Franklin et al. (2002)   Haila (1994)   Kuuluvainen (2002)   Lampainen et al. (2004)   Deal (2018)   Vanha-Majamaa et al. (2007)	8
REW	Svenning et al. (2016)   Lorimer & Driessen (2014)   Lorimer et al. (2015)	37

Key: Nature-Based solution (NBS); forest restoration (FR); forest landscape restoration (FLR); afforestation (AFF); rewilding (REW); ecosystem (based) adaptation (EBA); integrated land(scape) management (ILM).

### 3.1.4 The use of concepts across different types of studies

Nature-based terms were used across empirical, modelling, mixed modelling/empirical, review, reflection/conceptual and mixed types of studies. However, we observed differences in the relative use of terms across the study types. While ‘Afforestation’ was confined in our sample to modelling studies, and ‘Forest Restoration’ to empirical and review studies, the use of other terms was more balanced across study types. ‘Ecosystem-based Adaptation’, ‘Nature-based Solutions,’ and ‘Rewilding’ had broadly comparable uses across study types, with the heaviest use in empirical, followed by review studies. On the other hand, ILM and FLR were most frequently used in reflection/conceptual studies (Figure 3). The scale of the use of these two terms may explain this, since these terms were associated with large spatial scales (Figure 7), which limited the possibility of conducting empirical studies. In addition, these terms may be vaguely defined (ILM), or too recent and still evolving (FLR), leading to a weaker representation in empirical studies and a stronger in conceptual ones.

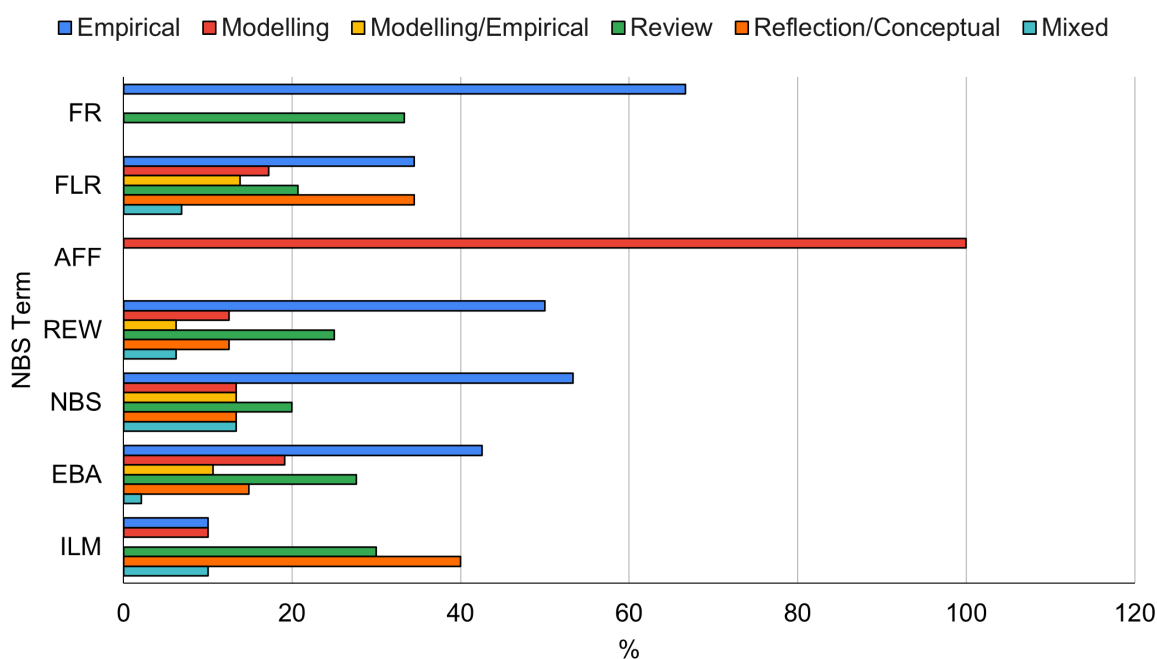


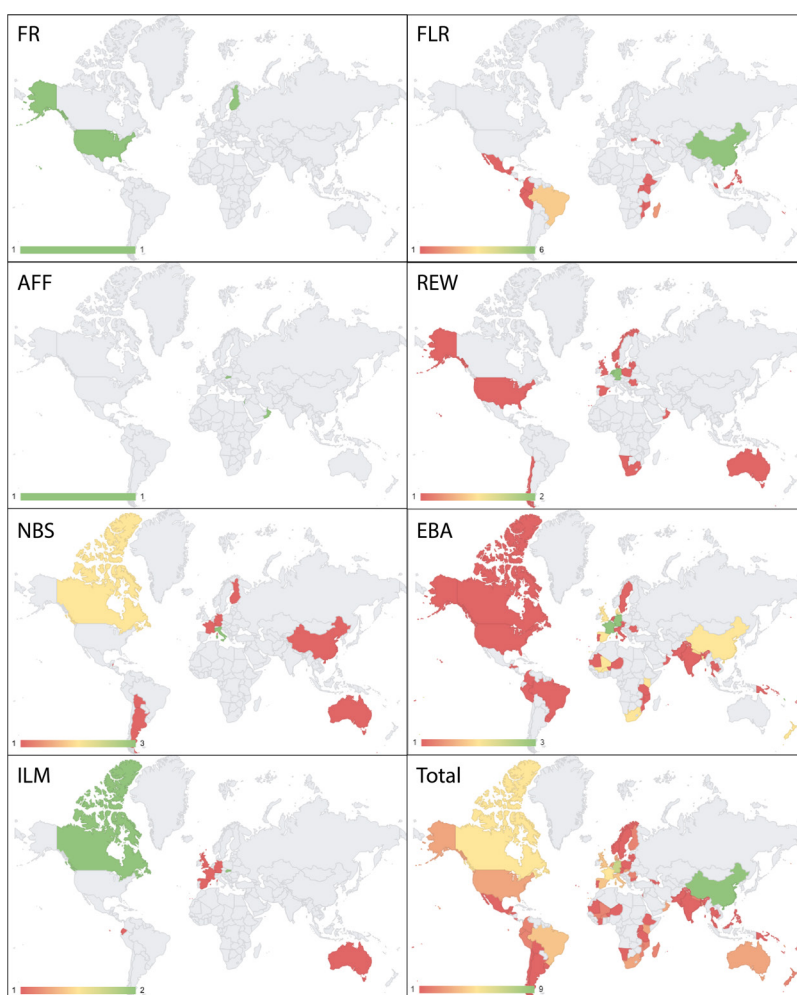
Figure 3: Use of concepts across study types as a percentage of each nature-based term definition total.



## 3.2 The use of nature-based terms across scales

### 3.2.1 Geographic distribution of the use of nature-based terms

The geographic distribution of nature-based terms showed interesting patterns. Some terms were exclusively or almost exclusively confined in their use to the global North, such as ‘Forest Restoration’ (evidence probably inconclusive due to the small sample size), and ILM. Similarly, ‘Rewilding’ and ‘Nature-based Solutions’ were mostly used in the global North, plus emerging economies of Asia, southern Africa and South America. Conversely, FLR is a term almost exclusively confined to the global South, where it is evenly distributed across Latin America, Africa and Asia. This agrees with César et al. (2021), who showed that the number of publications published by authors in North America, Russia, Australia and Oceania was far greater than actual projects implemented in those areas. The distribution of FLR projects globally mirrors the pledges made to the Bonn Challenge (Stanturf and Mansourian 2020). EBA was the term used most equitably across the globe. While it showed a ‘hotspot’ use in Europe, this was closely followed by China, and eastern, southern and western African countries. The term was also used across North and South America, as well as western, southern, and south-eastern Asia, as well as Oceania (Figure 4).



**Figure 4:** Geographic use of nature-based terms definitions by country.

### 3.2.2 Application of nature-based concepts by land use

Forest alone or with other land uses (agriculture and rural) was the most common land use context, in which nature-based terms were used, apart from NBS, which proved to be largely confined to urban contexts. While the clearly dominant use of FLR and REW in forests was not surprising, that of FLR, which according to its rather uniformly accepted definition (Table 4) should capture all other landscape mosaics, was notable. Similarly, the use of ‘Afforestation’ in forests contradicts the FAO definition of the term, which confines it to non-forest land use (FAO, 2020). Once again, EBA was a term well used across all land use types. ILM is a term used in mosaic landscapes consisting of rural, agriculture and forest land uses that plays a very subordinate role in other land use types (Figure 5).

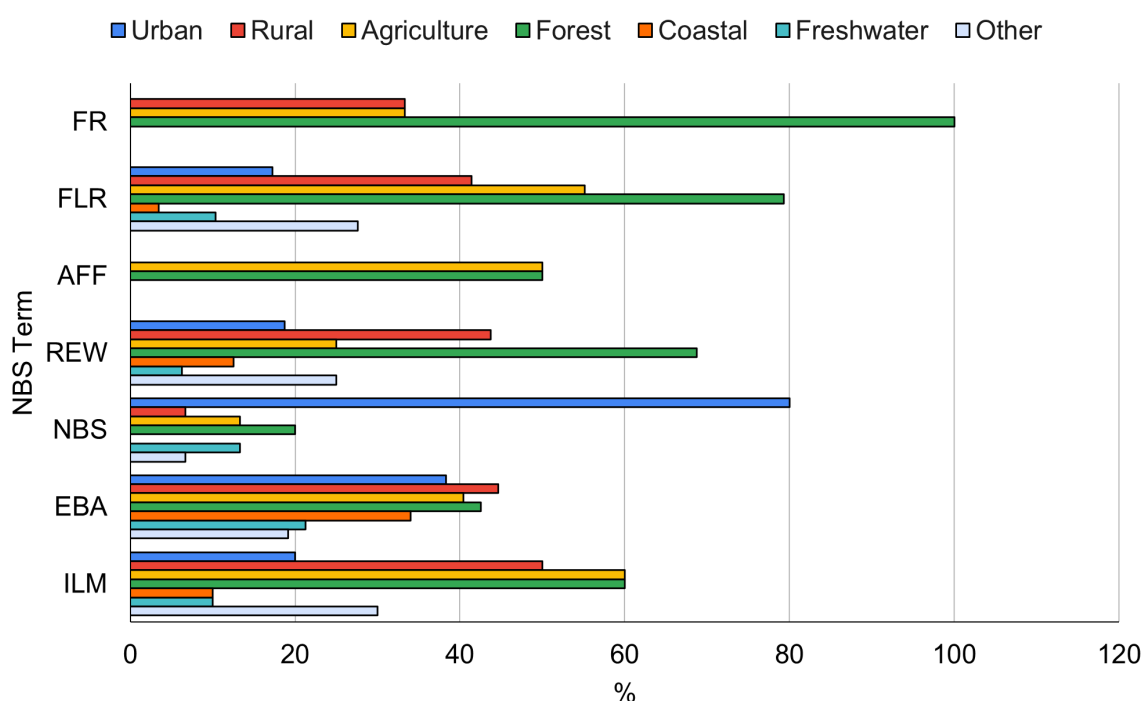


Figure 5: Application of nature-based term by land use.

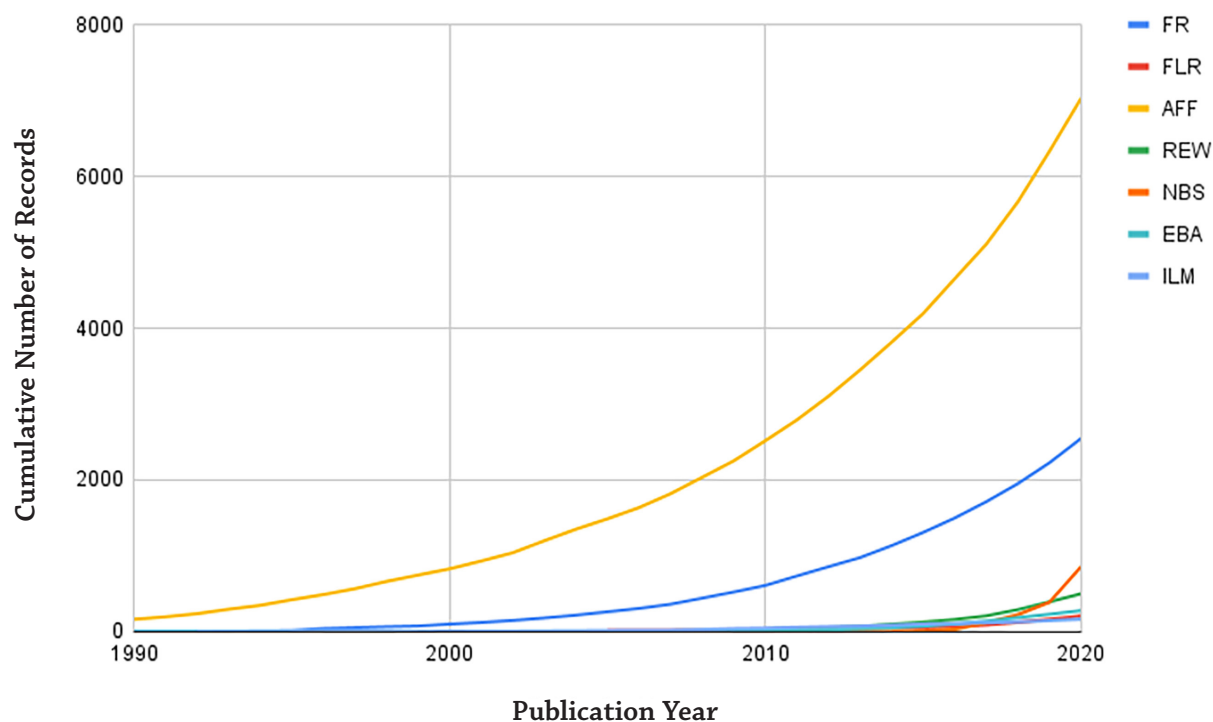
### 3.2.3 The use of nature-based terms across time

The emergence of nature-based terms in the scientific literature stretches over a substantial time period. The more ‘classical’ forestry terms, such as ‘Afforestation’ and ‘Forest Restoration’ first appeared in 1903 and 1970, respectively. They were followed by terms describing more holistic and integrated approaches, such as ‘Ecosystem-based Adaptation’ in 1983 and ‘Integrated Landscape Management’ in 1992 that were pre-dated by concepts of integrated watershed management (e.g., 2000 BC in China; (Wang et al., 2016), and coastal zone management (Clark, 1997)). ‘Rewilding’ emerged in 1999 as a concept applied to reintroduction of animals, especially predators and large herbivores,

followed by the most recent terms of ‘Forest Landscape Restoration’ in 2002 and ‘Nature-Based Solutions’ in 2009 (**Table 6**). While the older terms ‘Afforestation’ and ‘Forest Restoration’ clearly dominated the cumulated number of records, ‘Nature-Based Solutions’ as the most recent term has clearly outpaced the remaining terms to emerge as the third most frequent term (**Figure 6**).

**Table 6:** Earliest use of NBS terms.

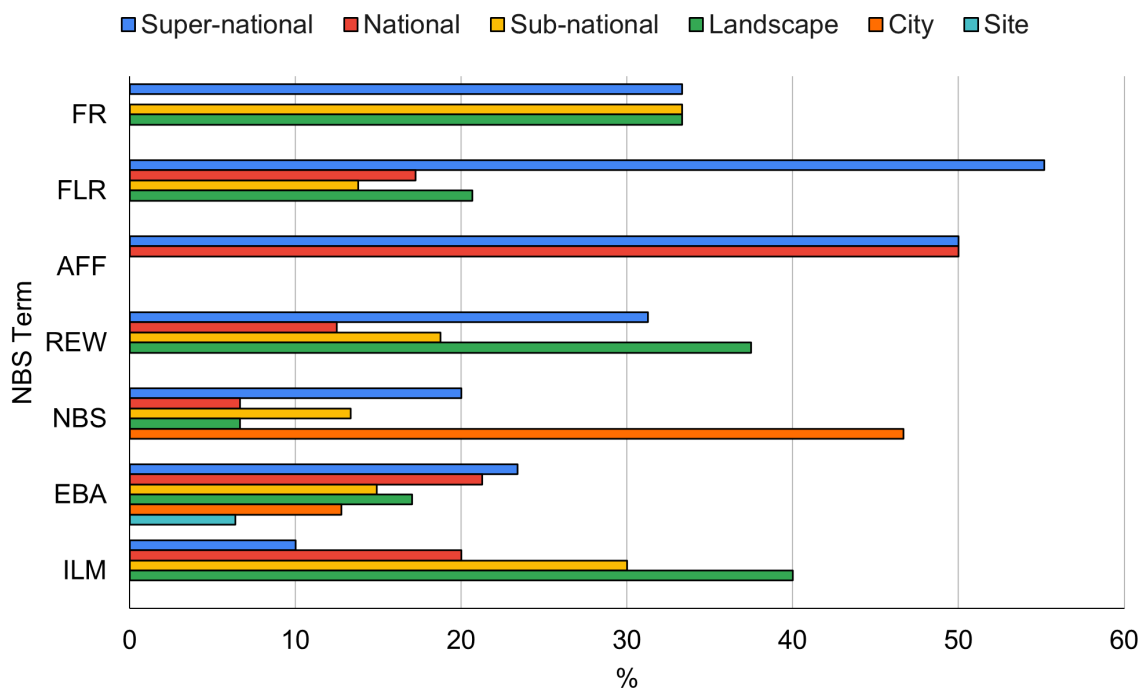
Term	Earliest Date (WoS)	Earliest Definition
AFF	1903	Schlich, W. The Afforestation of the Black Country. <i>Nature</i> 67, 395 (1903). <a href="https://doi.org/10.1038/067395a0">https://doi.org/10.1038/067395a0</a>
FR	1970	Larouche, R., (1970). Forest Restoration in Valleys, Red-Valley. <i>Pulp and Paper Magazine of Canada</i> , 71(2), p.85.
EBA	1983	Vavilin, V.A. and Vasiliev, V.B., (1983). Dependence of biological treatment rate on species composition in activated sludge or biofilm. I: A biological treatment model with ecosystem adaptation. <i>Biotechnology and Bioengineering</i> , 25(6), pp.1521-1538.
ILM	1992	L. Bélanger, C. Camiré, and Y. Bergeron. Ecological land survey in Quebec. (1992). <i>The Forestry Chronicle</i> . 68(1): 42-52. <a href="https://doi.org/10.5558/tfc68042-1">https://doi.org/10.5558/tfc68042-1</a>
REW	1998	Foreman, D., (1998). The wildlands project and the rewilding of North America. <i>Denv. UL Rev.</i> , 76, p.535.
FLR	2002	Barrow, E.G., et al. (2002). <i>Forest Landscape Restoration: Building Assets for People and Nature: Experience from East Africa</i> . IUCN.
NBS	2009	N. Kabisch et al. (eds.), (2017). <i>Nature-based Solutions to Climate Change Adaptation in Urban Areas, Theory and Practice of Urban Sustainability Transitions</i> , DOI 10.1007/978-3-319-56091-5_1



**Figure 6:** Cumulative number of records of keyword search terms through time 1990-2020.

### 3.2.4 The use of nature-based terms across space

We identified a relationship between spatial scales and the use of certain nature-based terms. While some terms clearly belonged to a certain spatial scale, such as NBS to the city, ILM to the landscape, and FLR to the super-national scales, others show a more diversified use across spatial scales. The dominant association of FLR with super-national scales contradicted findings of César et al. (2021), who found FLR mostly referred to scales smaller than an ecoregion and larger than a site; likely this was due to different search strategies. EBA once again showed the weakest association with any category and was equally used across spatial scales (**Figure 7**).



**Figure 7:** Scale of Concept – by nature-based term.

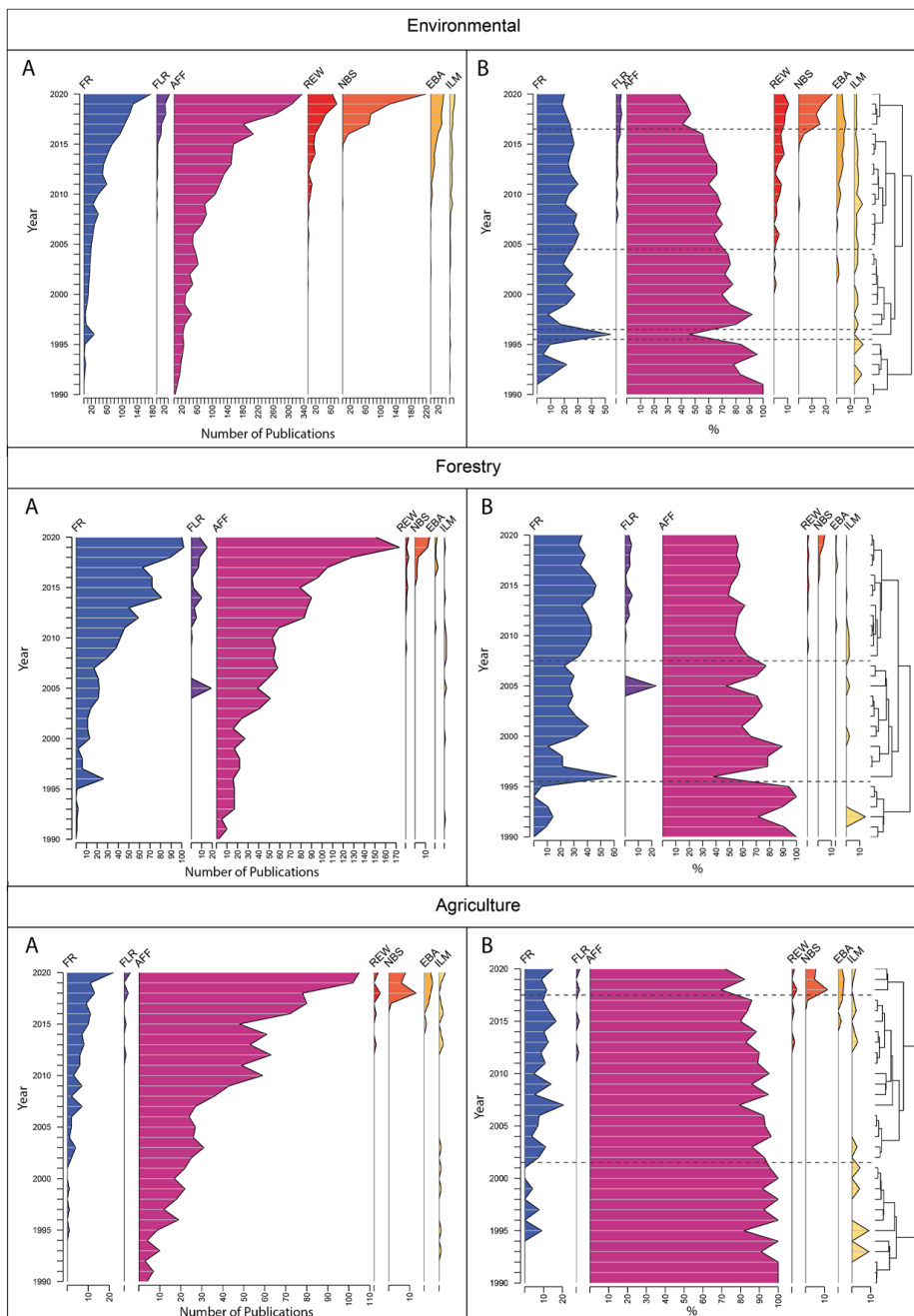
### 3.3 Use of nature-based terms by different disciplines through time

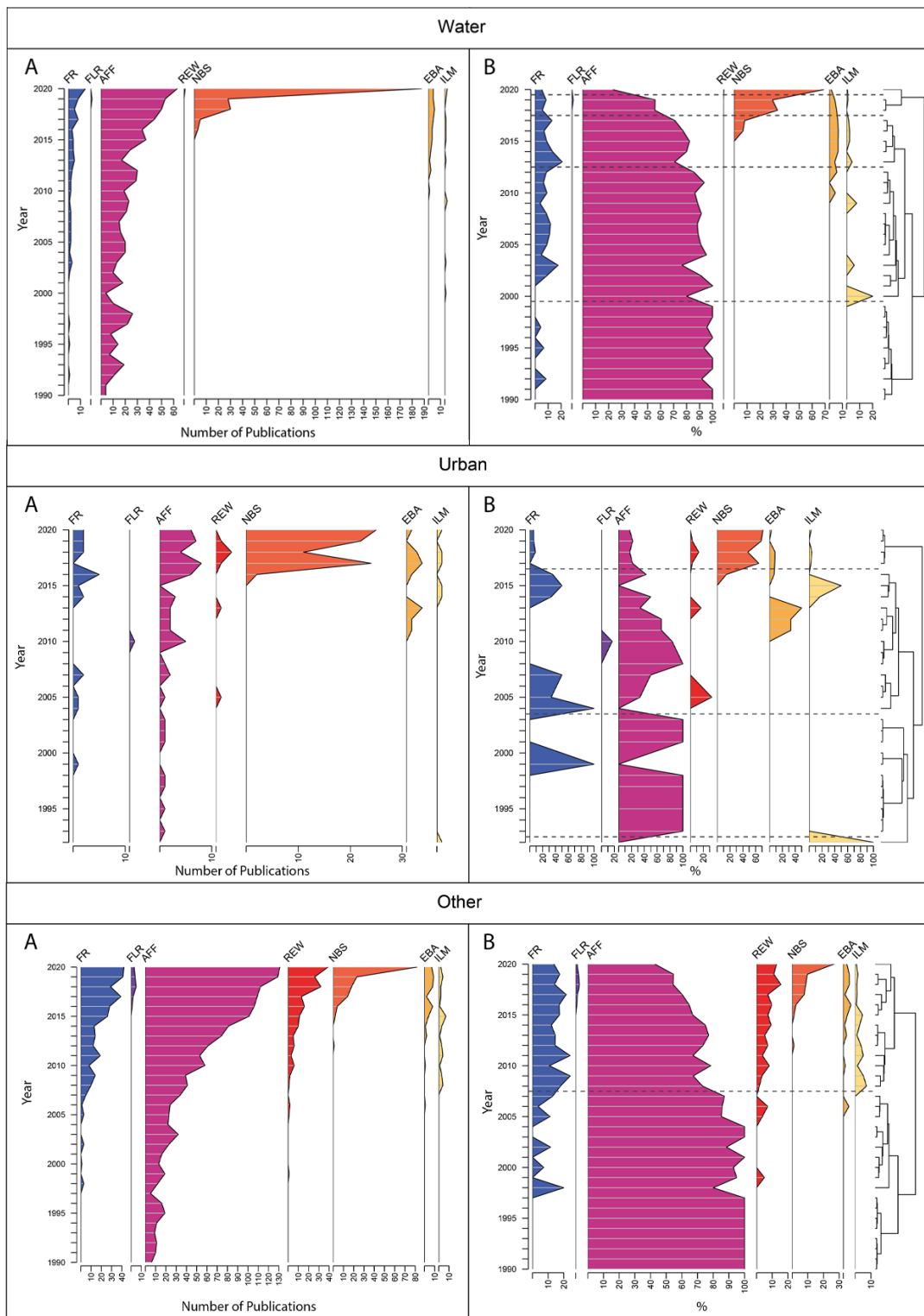
The seven nature-based terms, grouped by six Web of Science (WoS) domains (Table 2), showed distinct temporal trends from 1990 to 2020 (Figure 8). The number of publications by year and as a percentage of each year indicated an increase or decrease in the amount of published literature. ‘Afforestation’ (AFF) and ‘Forest restoration’ (FR) appeared earlier in all domains than the other terms. As noted above, AFF dated to early in the previous century (Schlich, 1903), forest restoration appeared even in the urban domain in the mid-1990s (Figure 8). ‘Nature-Based Solutions’ (NBS), EBA, and ILM were relative newcomers in all domains. Interestingly, ILM appeared early in the urban domain (1990) with a hiatus until 2013; ILM was present in the environmental, forestry, and water domains in small numbers throughout the 30 years of our record. Rewilding (REW) appeared sporadically in the urban domain. Of these three concepts (ILM, REW, NBS), only NBS appeared in any large measure in the forestry domain.

Constrained hierarchical clustering of the standardised (percentage) data identified 2-5 discrete time periods for each domain (Figure 8). With five time periods, ENV showed the most volatility in the publication record of all domains. In the earliest interval of 1990-1995, the record was dominated by publications in AFF and FR, with a lesser presence of ILM. A cluster from 1995 to 1997 showed a spike in FR and a dip in AFF and

ILM publications. From then on, the numbers of FR and ILM publications were stable, AFF slightly declined, and the other terms emerged (first REW and EBA, then NBS most recently).

The concept of FLR was first defined in 2002 (Mansourian, 2018) and appeared in our sample in 2005 (Table 6). The most prominent appearance was in the forestry domain in 2005 (Figure 8) and since 2015 in environmental. Curiously FLR did not appear in the water domain, even though mangrove and wetland forest restoration are active areas of research (Friess et al., 2020); perhaps these publications used the concept of forest restoration, as was apparent in the urban domain.



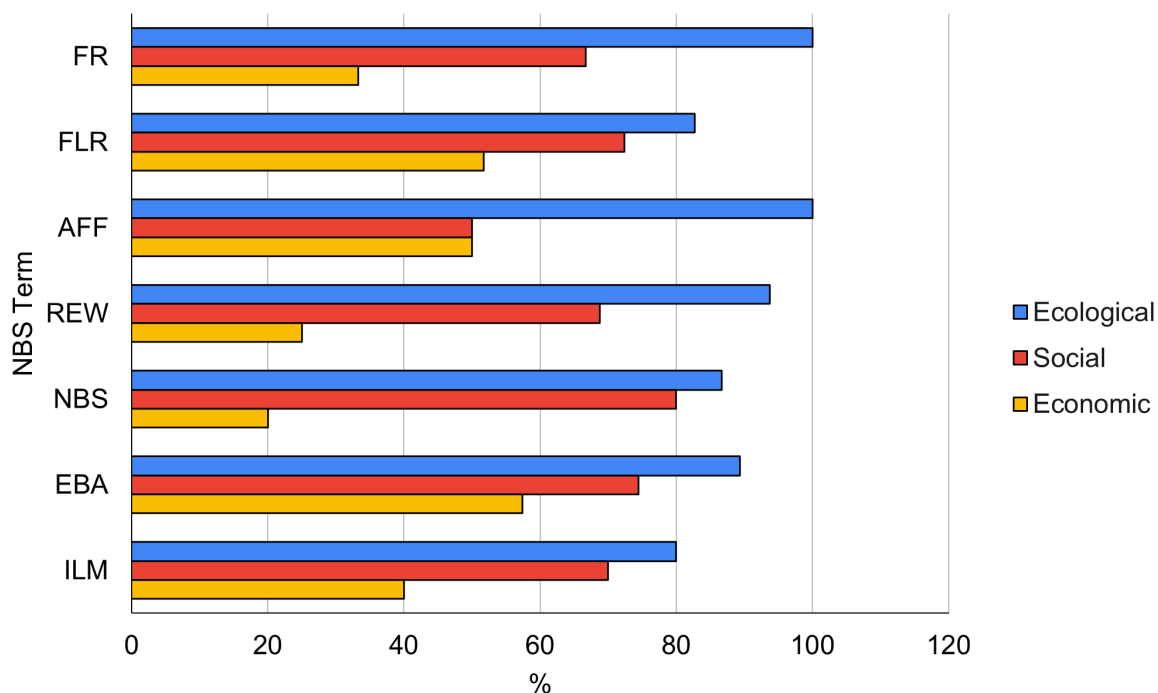


**Figure 8:** Publications by year for each WoS domain.

(A) Number of publications by year for each WoS domain [list domains] representing key search terms; (B) Percentage of publications by year for each WoS domain [list domains] representing key search terms.

### 3.4 Recognition of sustainability pillars across the nature-based terms

The three pillars of sustainability (ecological, social, and economic) were regularly mentioned in publications with the greatest emphasis on ecological aspects (**Figure 9**), even in FLR publications where ecological and social aspects, by definition, should be on equal footing. Not surprising, economic aspects were mentioned the least frequently; this was most apparent in the NBS publications, while economics most frequently (more than 50%) appeared in EBA publications. The paucity of economic considerations is a frequent criticism of restoration projects, especially lack of cost data (Robbins & Daniels, 2011; Wainaina et al., 2020). Though large-scale forest restoration in developing countries was initiated in the 1970s primarily for industrial and economic considerations, since the 1990s – the cut-off point for publications to be included in our sample – priorities shifted towards local livelihoods and more recently towards biodiversity and ecosystem services (de Jong et al., 2021). Nevertheless, economic hurdles remain weakly addressed in the successful implementation of large-scale forest restoration (Saraiva et al., 2020).



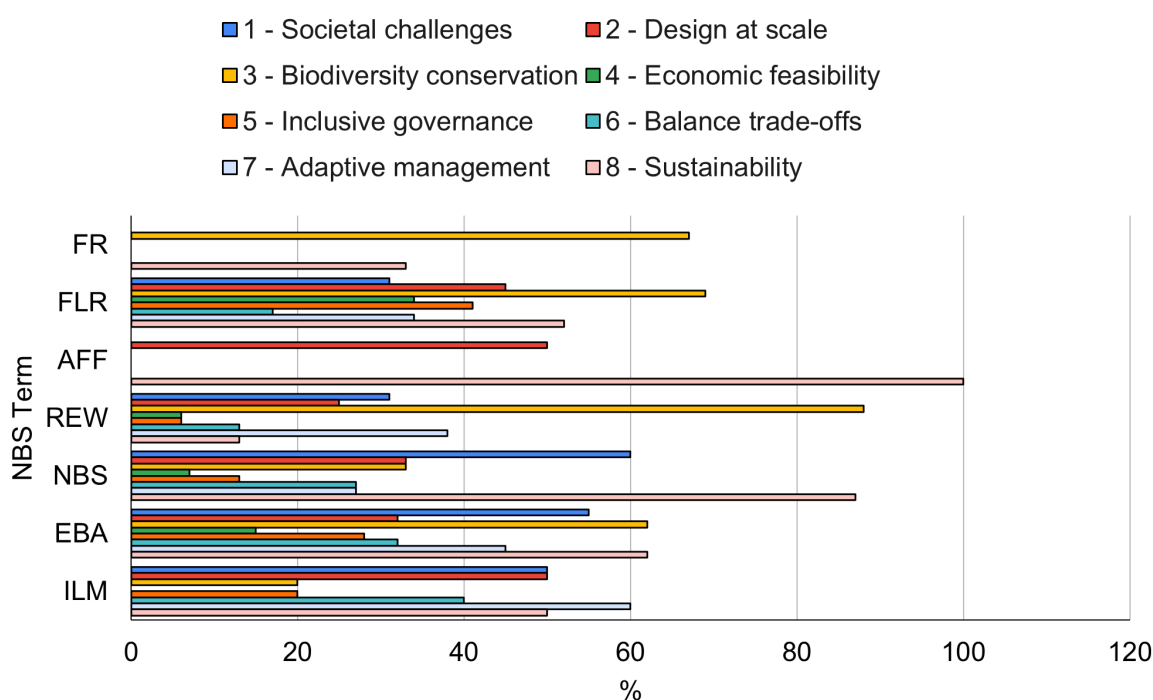
**Figure 9:** Mention of sustainability pillar for each nature-based concept.

The seventeen Sustainable Development Goals (SDGs) were mentioned regularly in our sample. Not surprisingly, SDG 15, Life on Land, appeared in all types of publications (data not shown). Only the FLR and NBS publications mentioned all seventeen SDGs. The reported sustainability impact was mostly positive with some mixed; no publication indicated a negative sustainability impact (data not shown).



### 3.5 IUCN Global Standards for Nature-Based Solutions

Nature-Based Solutions were defined by IUCN Members at the 2016 World Conservation Congress (IUCN, 2016), and the concept was further refined through the science-based development of eight NBS principles, as expressed by Cohen-Shacham et al., (2019). These were further operationalized for practice in form of eight NBS standards (IUCN, 2020) that include (i) NBS effectively address societal challenges; (ii) design of NBS is informed by scale; (iii) NBS result in a net gain to biodiversity and ecosystem integration; (iv) NBS are economically viable; (v) NBS are based on inclusive, transparent and empowering governance processes; (vi) NBS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits; (vii) NBS are managed adaptively, based on evidence; and (viii) NBS are sustainable and mainstreamed within an appropriate jurisdictional context. Despite the fact that these principles were defined after most of our sample was published, most of the publications recognized all the principles (**Figure 10**). The ILM publications failed to mention only economic feasibility, but FR and AFF mentioned only two of the eight principles (respectively biodiversity conservation and sustainability, and design at scale and sustainability).



**Figure 10:** Recognition of the IUCN Global Standards for Nature-Based Solutions Principles for each nature-based concept.

### 3.6 Implications of scale

The scale addressed in each of the publications was categorized as super-national (i.e., global or at least involving more than one country), national, sub-national (i.e., region or regions within a country), landscape(s), city (for strictly urban-focused publications, and site-specific. Within each scale, publications were categorized according to their impact on eleven aspects of sustainability: (i) adaptation; (ii) biodiversity; (iii) carbon sequestration and storage (iv) ecosystem services; (v) local people/communities; (vi) indigenous people/communities; (vii) land degradation; (viii) livelihoods; (ix) tenure; (x) wood production; and (xii) other (**Table 7**). Mentions are presented as percentages of publications to make them comparable across concepts. At the global or super-national scale, biodiversity and ecosystem services were mentioned in types of publications except afforestation, and only FLR publications mentioned all aspects of nature-based concepts except Indigenous communities.

Publications on EBA at the national level mentioned all concepts except wood production and tenure and there were no FR publications at this level; only EBA publications mentioned nature-based concepts in publications at all levels. There were no AFF publications at scales below the national level. Ecosystem services, land degradation, and biodiversity were the most frequently mentioned concepts in national level publications. At the sub-national level, land degradation and adaptation were the most frequently mentioned concepts, followed by biodiversity and local communities. Biodiversity and local communities were most frequently mentioned at the landscape level and surprisingly, tenure was not mentioned in any landscape-level publications. At the lowest levels, city publications were restricted to NBS and EBA and to EBA at the site-level. At both levels, adaptation, ecosystem services, and local communities were the most frequently mentioned nature-based concepts.

The most frequently mentioned concepts at all scales were biodiversity (82% of cells) and ecosystem services (73%); local communities, adaptation, land degradation, and livelihoods were mentioned less frequently (64%-69%) but considerably more than Indigenous communities (38%), carbon (36%), tenure (21%), or wood production (14%).

**Table 7:** Implementation of nature-based concepts at different scales.

Scale	Focus of Sustainability Impact	FR	FLR	AFF	REW	NBS	EBA	ILM
Super-N	Adaptation	0	31	0	20	67	100	100
	Biodiversity	100	75	0	100	67	91	100
	Carbon sequestration and storage	0	25	100	0	100	36	0
	Ecosystem services	100	81	0	60	67	91	100
	Local people/ communities	0	50	0	40	0	64	0
	Indigenous people/ communities	0	0	0	20	0	18	0
	Land Degradation	0	56	100	40	0	27	0
	Livelihoods	0	31	0	20	33	55	100
	Other	0	13	0	0	33	9	0
	Tenure	0	6	0	0	0	0	0
	Wood production	0	6	0	0	0	0	0
National	Adaptation	N/A	0	0	0	100	90	0
	Biodiversity	N/A	20	0	100	0	50	50
	Carbon sequestration and storage	N/A	0	0	0	0	20	0
	Ecosystem services	N/A	80	0	50	100	100	50
	Local people/ communities	N/A	40	0	50	0	50	0
	Indigenous people/ communities	N/A	20	0	0	0	20	0
	Land Degradation	N/A	20	100	0	0	60	50
	Livelihoods	N/A	20	100	0	0	60	0

Scale	Focus of Sustainability Impact	FR	FLR	AFF	REW	NBS	EBA	ILM
	Other	N/A	0	0	0	0	10	50
	Tenure	N/A	0	0	0	0	0	0
	Wood production	N/A	0	0	0	0	0	0
Sub-National	Adaptation	0	25	N/A	33	100	86	33
	Biodiversity	0	50	N/A	100	50	43	33
	Carbon sequestration and storage	0	0	N/A	0	50	14	0
	Ecosystem services	0	50	N/A	0	100	86	33
	Local people/ communities	100	50	N/A	33	50	57	0
	Indigenous people/ communities	0	25	N/A	0	0	14	0
	Land degradation	100	50	N/A	33	100	29	0
	Livelihoods	0	50	N/A	0	0	71	33
	Other	0	0	N/A	0	0	0	33
	Tenure	0	0	N/A	0	0	0	0
	Wood production	0	0	N/A	0	0	0	33
Landscape	Adaptation	0	17	N/A	0	0	38	75
	Biodiversity	100	17	N/A	67	0	50	25
	Carbon sequestration and storage	0	17	N/A	0	0	0	0
	Ecosystem services	0	50	N/A	33	0	50	25
	Local people/ communities	0	17	N/A	50	100	25	50
	Indigenous people/ communities	0	0	N/A	0	0	25	25

Scale	Focus of Sustainability Impact	FR	FLR	AFF	REW	NBS	EBA	ILM
	Land Degradation	0	83	N/A	17	0	13	50
	Livelihoods	0	33	N/A	17	0	50	0
	Other	0	17	N/A	17	0	0	0
	Tenure	0	0	N/A	0	0	0	0
	Wood production	0	17	N/A	0	0	13	0
City	Adaptation	N/A	N/A	N/A	N/A	43	83	N/A
	Biodiversity	N/A	N/A	N/A	N/A	29	33	N/A
	Carbon sequestration and storage	N/A	N/A	N/A	N/A	14	0	N/A
	Ecosystem services	N/A	N/A	N/A	N/A	43	50	N/A
	Local people/ communities	N/A	N/A	N/A	N/A	43	50	N/A
	Indigenous people/ communities	N/A	N/A	N/A	N/A	0	0	N/A
	Land Degradation	N/A	N/A	N/A	N/A	0	0	N/A
	Livelihoods	N/A	N/A	N/A	N/A	0	0	N/A
	Other	N/A	N/A	N/A	N/A	14	17	N/A
	Tenure	N/A	N/A	N/A	N/A	0	0	N/A
	Wood production	N/A	N/A	N/A	N/A	0	0	N/A
Site	Adaptation	N/A	N/A	N/A	N/A	N/A	67	N/A
	Biodiversity	N/A	N/A	N/A	N/A	N/A	33	N/A
	Carbon sequestration and storage	N/A	N/A	N/A	N/A	N/A	0	N/A
	Ecosystem services	N/A	N/A	N/A	N/A	N/A	67	N/A

Scale	Focus of Sustainability Impact	FR	FLR	AFF	REW	NBS	EBA	ILM
Site	Local people/ communities	N/A	N/A	N/A	N/A	N/A	100	N/A
	Indigenous people/ communities	N/A	N/A	N/A	N/A	N/A	0	N/A
	Land Degradation	N/A	N/A	N/A	N/A	N/A	33	N/A
	Livelihoods	N/A	N/A	N/A	N/A	N/A	0	N/A
	Other	N/A	N/A	N/A	N/A	N/A	0	N/A
	Tenure	N/A	N/A	N/A	N/A	N/A	0	N/A
	Wood production	N/A	N/A	N/A	N/A	N/A	0	N/A

Mention (as a percentage of publications) of how each of the nature-based concepts are implemented at different scales on: (i) adaptation; (ii) biodiversity; (iii) carbon sequestration and storage (iv) ecosystem services; (v) local people/communities; (vi) indigenous people/communities; (vii) land degradation; (viii) livelihoods; (ix) tenure; (x) wood production; and (xii) other for each nature-based concept. (N/A means that there was no publication of that type at that scale, whereas 0 indicates that none of the publications of that type at that scale mentioned the nature-based concept). Cells are color-coded: green indicates 50% or more, red indicates 0%, and yellow cells are greater than 0% but less than 50%.

4

## 4. CONCLUSIONS

We observed definite temporal and geographic trends in ways nature-based concepts were used in the scientific literature. There was a trend toward more integrative, broader scale approaches (i.e., landscapes) with the early emergence of ILM, and subsequently of EBA and NBS. The terms AFF and FR appeared first in the literature, respectively 1903 and the 1970s; ILM and EBA almost two decades later in 1992; less than a decade later REW (1999), followed by FLR in 2002; and roughly another decade for NBS (2009). Most publications that defined the terms used, referred to authoritative standards, rather than offering the authors' definitions, however, many different sources were cited. Forests and rural land uses dominated the context of publications except for NBS, which emerged primarily from an urban/city context. There was a clear geographic divide: FLR publications dominantly arose from the global South while the other terms came either from the global North or from the economically developed countries plus emerging economies in Africa, Asia, and South America. Forest landscape restoration (FLR) was most prominent in the forestry domain and to a slightly lesser extent in the agriculture domain and barely detectable in the other domains. Of all the terms, FLR was the most cognizant of sustainability concepts.

The meaning of words can be transient, changing over time by taking on new meanings and possibly incorporating older meanings. Different scientific disciplines have embraced nature-based concepts and operationalized them by practitioners in different ecological, social and historical contexts. Some terms, such as rewilding (Jørgensen, 2015; Perino et al., 2019) and forest landscape restoration (Mansourian, 2018), originated in the academic world and were embraced by the policy organizations and popularized by NGOs; other terms, such as ecosystem-based adaptation (Barkdull & Harris, 2019; Travers et al., 2012) and nature-based solutions (Nesshöver et al., 2017a; Seddon et al., 2020), followed the opposite path, from the policy realm to the scientific. Languages evolve and words can become plastic, obscuring nuance and replacing precision with vague, even contradictory 'buzz words.'

### 4.1 Characterisation of nature-based terms

#### 4.1.1 Ecosystem-based Adaptation

'Ecosystem-based Adaptation' emerged as a specific term under the umbrella of the 'Ecosystem Approach' coined by the UN Convention on Biodiversity. 'Ecosystem-based Adaptation' emerged from the global climate change and biodiversity agenda and referred to the use of ecosystem services in adapting social-ecological systems to the adverse



impacts of climate change (Cohen-Shacham et al., 2016). The term was first defined by the Convention on Biodiversity in 2009 and was promptly adopted in the terminology used by the other two Rio Conventions (UNFCCC and UNCCD). The conventions have not only adopted the term but also explicitly use ‘Ecosystem-based Adaptation’ as a fundamental approach in their key strategies to achieve global environmental sustainability goals (Convention on Biological Diversity, 2021; UN Environment, 2021). More recently, ‘Ecosystem-based Adaptation’ has been emphasized further as an approach to synergistically mitigate the negative impacts of the COVID pandemic, while delivering climate change adaptation gains (*Increasing Resilience Through Natural Solutions* | UNFCCC, n.d.). In the scientific literature, EBA was the nature-based term for which a definition was most frequently used. As opposed to several other nature-based terms, EBA was used very frequently in the methods sections of scientific publications, indicating that the approach was strongly integrated into the scientific methodology. Though CBD (2009) was the most frequent definition used, the second most frequent definitions were authors’ customized definitions, which indicated that the term covered a broad concept of which there was still some confusion (Nalau et al., 2019). The frequent use of the term in empirical and review papers indicated that EBA has been well adopted by scientists. The term was used without bias for geography or land use types.

#### 4.1.2 Integrated Landscape Management

‘Integrated Land(scape) Management’ emerged as a key term under the umbrella of ‘Landscape Approaches’ that emphasized the interconnectedness of mosaic elements of landscapes and the mutual interdependency of various land-based sectors and actors, acting and interacting at different scales across the landscape. Therefore, ILM has a strong focus on collaboration between stakeholders at the landscape scale (S. J. Scherr et al., 2012). ‘Landscape Approaches’ emerged primarily from biodiversity conservation and landscape ecology and learnings from the attempted integration and reconciliation of conservation priorities with local economic needs in the framework of Integrated Conservation and Development Programmes (Reed et al., 2015). Integrated ‘Landscape Approaches’ have been embraced by global development stakeholders, including the World Bank, the Global Environment Facility and others as a funding criterion of interventions that target the sustainability of land, water, and natural resources (Reed et al., 2020). The term highlights the need to see primarily forest, agricultural and other rural (**Figure 4**) land uses in the context of mutual interdependencies, and throughout the scientific literature largely remains conceptual in its use (**Figure 3**). Though the term emerged in the scientific literature in the early 1990s (**Table 4**), its adoption has been slow to the extent that in recent years it has been overtaken by all other investigated nature-based terms as seen in the cumulative number of records (**Figure 7**).

### 4.1.3 Afforestation

Afforestation is an old forestry term, dating from at least the beginning of the last century (Schlich, 1903) but the practice is much older, at least to the 1500s when the word first appeared in English. Afforestation is the act or process of establishing a forest especially on land not previously forested, implying a change in land use. The current FAO definition is the conversion from other land uses into forest, or the increase of canopy cover to the 10% defined threshold for forest (FAO, 2001). It is distinct from reforestation, which is the re-growth of forests after a temporary (< 10 years) condition with less than 10% canopy cover due to human-induced or natural perturbations (FAO, 2001). A survey conducted in the 1990s (Lund, 1999) found 34 different definitions of afforestation, 20 implying a change in land cover and 14 specified a change in land cover and use.

Generally, afforestation is taken to mean planting trees, but almost half of the definitions identified by Lund (1999) included forests newly established by natural regeneration. How long the land had to be in a non-forest state was variable; most definitions did not specify a term, some said ‘historically’ non-forested; the FAO (2001) definition also says, ‘within living memory’. Some definitions used a non-forest interval from 30 to 100 years (Lund, 1999). The lack of a specific period for non-forest land use created confusion, especially in distinguishing between reforestation and afforestation when a degraded forest has been in a derelict state for more than 10 years (e.g., regeneration failure and capture by invasive grasses or shrubs (Foli, 2019; Guuroh et al., 2021), or farmed for 10-20 years (Stanturf et al., 2009). In such cases, some authors have used an obsolete term, reafforestation, which originally meant to restore (land) to the legal status of a forest or hunting ground.

Afforestation in practice has been controversial, on three counts: (1) Government agencies have planted trees on common lands without regard for local communities (Kanowski, 1997; Overbeek et al., 2012). (2) Afforestation objectives are commonly timber production or watershed protection and using single-species plantations, often of non-native species (Dodet & Collet, 2012). (3) Afforestation of non-forest land has mistaken native grasslands for land cleared for pasture (Veldman et al., 2015, 2017). The resulting conflation of ‘afforestation’ with these practices has engendered opposition to tree planting for legitimate restoration of degraded land.

### 4.1.4 Forest Restoration

Forest restoration was appropriate to describe creating new forests areas through afforestation; it has also been applied to restoring severely disturbed forests (e.g., following intense wildfire or cyclones), especially when species composition was significantly altered (for example, converting Norway spruce stands to broadleaves after winter storms).

Planting forests to restore degraded land has a long history predating the term's use (Stanturf, 2005). The motivation often was to reduce soil erosion and sedimentation of water bodies (Stanturf, Palik, Williams, et al., 2014). Forest restoration arose from mostly technical practice rather than international policy initiatives, thus there is no authoritative definition of the term. Indeed, some have questioned how FR differs from standard silvicultural practices and forest restoration utilizes many silvicultural techniques (Sarr & Puettmann, 2008; Wagner et al., 2000), but the extraordinary effort needed to restore degraded, damaged, or destroyed forests sets restoration apart (Stanturf, Palik, & Dumroese, 2014).

Forest restoration has also described efforts to convert non-native monocultures to mixed stands comprised of native species, to restore historic fire regimes after periods of suppression and build-up of hazardous fuel loads, and to transform stands from simple to complex structures (Stanturf, Palik, Williams, et al., 2014). For some authors, forest restoration is only 'real' restoration if the desired endpoint is some measure of historical fidelity, i.e., ecological restoration. Anything less is termed rehabilitation or replacement and not deemed restoration. This purist view has been challenged (Stanturf, Palik, Williams, et al., 2014) and in any event, has been overtaken by the need to adapt to climate change (Park et al., 2014).

#### **4.1.5 Forest Landscape Restoration**

Forest landscape restoration, or forest and landscape restoration, was defined in 2000 by a group of 30 social and natural scientists at a meeting in Spain. They defined FLR as 'a planned process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded landscapes' (WWF & IUCN, 2000). Their motivation was dissatisfaction with large scale plantations of single species, seeming neglect of the conservation potential of degraded primary and secondary forests, and negative impacts of plantation schemes on biodiversity and people (Mansourian et al., 2021). This was also a time when the international development community was interested in more integrative approaches (Wells & McShane, 2004). Later the Global Partnership on FLR (GPFLR) was established by WWF, IUCN and the UK Forestry Commission. In 2011, the Bonn Challenge on FLR was launched by IUCN and the German government, an attempt to restore 150 million ha of forested landscapes by 2020; this was expanded by the New York Declaration on Forests to 350 million ha by 2030.

The original definition of FLR has changed in two significant ways: first, 'planned process' was dropped from the definition, ostensibly to remove the implication that FLR was necessarily a top-down process. The question has arisen, whether spontaneous natural

regeneration resulting from agricultural land abandonment constitutes FLR. Natural regeneration as an intentional restoration technique can be considered FLR, if included within a landscape approach. After all, FLR is more than just planting trees. The second redefinition was the addition of ‘and,’ seemingly diluting the requirement that forests are a definitive element of FLR. Even without these wrinkles, what constitutes FLR has been poorly understood, to the point where actions have been mislabelled as FLR (Mansourian et al., 2021). For example, FLR is a landscape approach and stand-level interventions alone, even focused on restoring wildlife habitat, do not meet the standard of FLR. At the other extreme, FLR seeks to balance biodiversity and livelihoods and large-scale tree plantations of non-native species providing little benefit to local communities fall short of FLR principles (Seddon et al., 2019). Nevertheless, there are many examples of landscape-level restoration activities that approach the FLR standard (Mansourian et al., 2021; Stanturf & Mansourian, 2020).

#### **4.1.6 Rewilding**

The concept of rewilding dates to the 1980s when it originated in North America from the wilderness literature (Carver et al., n.d.). In the mid-1990s, rewilding was used to define a large-scale (i.e., continental) strategy to restore biodiversity (**Table 7**) through an interconnected network of reserves and re-introduction of apex carnivores (e.g., wolves). This 3C’s approach (core, corridors and carnivores) of trophic rewilding was an ecological restoration strategy that relied on increasing populations of extant, large fauna (Soulé & Noss, 1998). In 2005, this was extended to using species introductions (taxon replacement) to restore top-down trophic interactions and promote self-regulating biodiverse ecosystems (Corlett, 2016; Donlan, 2005).

Rewilding in Europe has taken a more pragmatic, less protectionist view. It can be traced to nature development in The Netherlands (Jepson et al., 2018). Herbivores, rather than carnivores, are emphasized as the active restoration agent in Europe but spatial connectivity is emphasized in both Europe and North America. The rewilding concept has evolved to encompass six uses of the term in the scientific literature distinguished by temporal context, i.e., the historic reference for loss of wild species (Jørgensen, 2015). In addition to the original 3Cs concept, trophic rewilding advocates the reintroduction of missing keystone species (including non-native proxies for extinct species), such as apex carnivores and large herbivores. Pleistocene rewilding is a particular type of trophic rewilding that aims to reintroduce megafauna extirpated since the Late Pleistocene while taxon replacement focuses on Holocene loss of native species on islands. Ecological (or passive) rewilding emphasizes the passive management of ecological succession in abandoned landscapes. Another form of rewilding involves the release of captive-bred animals to the wild, a form of assisted migration or species reintroduction (Novak et al., 2021).

Rewilding is a form of ecological restoration but distinguished from other practices by the emphasis on establishing conditions for relinquishing direct human management, relying on autonomous biotic and abiotic agents and processes. Other forms of ecological restoration are sustained and maintained by adaptive management and interventions (Clewell et al., 2000). Passive rewilding overlaps with other passive restoration approaches that rely on natural regeneration to restore forest landscapes (Chazdon & Uriarte, 2016; Stanturf et al., 2019).

#### **4.1.7 Nature-Based Solutions**

Though ‘Nature-Based Solutions’ was the most recently coined term, it has emerged as an umbrella term for approaches that promote nature and natural processes to mitigate and adapt to climate change as well as to achieve important co-benefits, including halting and reversing land degradation and conserving biodiversity (Eggermont et al., 2015). The two standard definitions for NBS as an umbrella term are fairly broad (refer to **Section 1.3 Definitions**), which at the same time makes them vague (‘Nature-Based Solutions’ Is the Latest Green Jargon That Means More than You Might Think,’ 2017). Therefore, NBS includes approaches that range from the use of nature to approaches that mimic natural systems to processes to replace structural engineering solutions. In fact, ‘blue-green infrastructure’ is an integral part of NBS (Albert et al., 2017). Accordingly, it is difficult “to draw the line as to what is considered as ‘nature’ or ‘natural’”, as pointed out by Nesshöver et al. (2017). In the scientific literature we found a strong dominance of the use of the latter NBS concept, primarily confined to urban settings and with a strong bias towards use in Europe. The distinct dichotomy in the use of NBS possibly stems from the fact that as opposed to the original definition by IUCN (Cohen-Shacham et al., 2016), which captures all land uses, the EU Commission through its Agenda 2020 Work Programme (European Commission, 2015) introduced the use of NBS as a term with strong connotation towards natural approaches that replace structural engineering solutions primarily in urban contexts.

## **4.2 Principles, standards of forest-related nature-based approaches**

The more recent and well-defined terms cover concepts that have been further specified through principles and the practical implementation of which is guided by standards. These principles and standards are useful guidance to better understand the fundamental aspects underlying the concepts and should be used alongside when taking reference to the concepts defined by the specific nature-based term. Widely accepted principles and/or standards exist for EBA, ILM, FLR, and NBS.

### **4.2.1 Ecosystem-Based Adaptation**

The Convention on Biological Diversity defined the principles of EBA (Conference of the Parties to the Convention on Biological Diversity, 2018). These overarching principles (which in turn are underpinned by more specific subordinate principles) include:

- Build resilience and enhance adaptive capacity
- Ensure inclusivity and equity in planning and implementation
- Achieve EBA on multiple scales
- Effectiveness and efficiency, e.g., through adaptive management, identifying limitations and trade-offs, integration of traditional knowledge, etc.

Several organizations have developed criteria and/or standards to further operationalize these principles. The criteria developed by the Friends of Ecosystem-based Adaptation include (Friends of Ecosystem-based Adaptation, 2017):

1. Reduce social and environmental vulnerabilities.
2. Generate societal benefits in the context of climate change adaptation.
3. Restore, maintain or improve ecosystem health.
4. Supported by policies at multiple levels; and
5. Support equitable governance and enhance capacities.

### **4.2.2 Integrated Landscape Management**

The five elements of Integrated Landscape Management (S. Scherr et al., 2013) include:

1. Shared or agreed management objectives that encompass multiple benefits (the full range of goods and services needed) from the landscape.
2. Field, farm and forest practices are designed to contribute to multiple objectives, including human well-being, food and fibre production, climate change mitigation, and conservation of biodiversity and ecosystem services.
3. Ecological, social, and economic interactions among different parts of the landscape are managed to realize positive synergies among interests and actors or to mitigate negative trade-offs.
4. Collaborative, community-engaged processes for dialogue, planning, negotiating and monitoring decisions are in place; and
5. Markets and public policies are shaped to achieve the diverse set of landscape objectives and institutional requirements.



In addition, the ten principles of the landscape approach (Sayer et al., 2013) are generally considered to apply to ILM, that falls under the umbrella concept of Integrated Landscape Initiatives (FAO, n.d.).

### **4.2.3 Forest Landscape Restoration**

The Global Partnership on Forest Landscape Restoration defined the six principles of FLR (Besseau et al., 2018). These include:

1. Focus on landscapes,
2. Engage stakeholders and support participatory governance,
3. Restore multiple functions for multiple benefits,
4. Maintain and enhance natural ecosystems within landscapes,
5. Tailor to the local context using a variety of approaches, and
6. Manage adaptively for long-term resilience.

In addition, the ten principles of the landscape approach (Sayer et al., 2013) are generally considered to apply to FLR, that falls under the umbrella concept of Integrated Landscape Initiatives (FAO, n.d.). Thus, multiple land uses (tree-based or not), can be included in an FLR project, for example regenerative agriculture.

### **4.2.4 Nature-Based Solutions**

The IUCN has developed eight Global Standards for NBS principles (IUCN, 2020), that were presented in **Section 3.5 IUCN Global Standards for Nature-Based Solutions Principles**.

## **4.3 Usefulness of nature-based concepts for achieving restoration of forest landscapes at scale**

Although FLR has been intimately connected to the Bonn Challenge, other integrated landscape initiatives, such as EBA and ILM are useful to account for the interconnectedness of landscape elements. Nevertheless, FLR has the distinct advantage of explicitly engaging the highly diverse actors that have a stake in the landscapes targeted for restoration. In addition, FLR has a distinct super-national connotation, which implied the usefulness of the concept for reviewing restoration efforts at scales. Older concepts such as AFF and FR certainly have their justification to be used in distinct land use types to provide a meaningful contribution towards ambitious restoration targets. AFF was a meaningful concept to be referred to when the conversion from non-forest to forest land is targeted and this happens either on a large scale or in landscapes of uniform land use, where interconnectedness with other landscape elements plays a subordinate role. The concept for FR was suitable in largely forested degraded landscapes. Rewilding was a concept restricted to countries of the global North and therefore may not be useful when working towards restoration targets under

the Bonn Challenge. Nevertheless, the concept can well describe meaningful approaches that contribute to restoration of forested landscapes in temperate regions, primarily of low population density. However, defaunation has a negative effect on forest regeneration worldwide (Gardner et al., 2019). Consequently, this term can become relevant in forest landscape restoration depending on the context. EBA does not directly lead to restoration of forest landscapes, although the concept includes important co-benefits that may provide meaningful contributions towards restoration targets. Very importantly, EBA was a concept that can be used without fear of bias in terms of geography, land use, or scale. Finally, NBS was an umbrella term, which in the sense of the IUCN (2016) definition can prove to be very helpful in clarifying approaches that may provide a meaningful contribution towards restoration targets in forested landscapes. However, users of the concept are warned not to use the term in the context for restoration in the sense of the European Commission (2015) definition, which has a strong connotation towards urban and engineered solutions.

#### **4.4 Recommendations for the use of NBS terms**

Words are mutable, changing over time. But when terms enter the popular vernacular, they can become vague or ‘plastic’ and loaded with added meaning. Sometimes this is done to accommodate organizational or policy goals, for example the evolution of FLR (removal of ‘planned process’, addition of ‘and’ to forest and landscape restoration). Science strives for precision of expression, and this can lead to obtuse jargon. To communicate clearly to non-technical audiences, it may be necessary to simplify messages, but this must be done carefully, with sufficient explanation to avoid confusion.

World views, value systems, and simply ecological context and professional experience shape word meaning and usage. Examples are natural, native, wild, wilderness; the common sense meaning of these words are imprecise and often encompass contradictory meanings. For example, rewilding; in North American experience, the term was influenced by concepts of wild and wilderness as free of any (or at least significant) human intervention. By contrast, in Europe, rewilding was a more pragmatic endeavour (Jepson et al., 2018). Another example is the evolving notion of the importance of reference sites in ecological restoration. Historical references were used as prescriptions for restoration and historical fidelity taken as a measure of success in the early days of the Society for Ecological Restoration (SER), which originated in North America. As the organization became more international and confronted the reality of cultural ecosystems in Europe, reference sites became less prominent. Indeed, historical fidelity was further diluted in the face of climate change.



Scientific terms change meaning, however, as new information and understanding develop. Policies and popular understanding based on older scientific understanding become obsolete and possibly maladaptive. Case in point, forest ecosystems are not static (steady state) but dynamic, subject to periodic disturbances. Hence policies and values based on unchanging forests and their ecological attributes can be counter-productive, as can be seen in fire suppression policies in the USA.

None of the nature-based concepts investigated have their original roots in the scientific literature, but have instead emerged from practice (Afforestation), or from the global change agenda related to biodiversity conservation and climate change ('Nature-Based Solution,' 'Ecosystem-based Adaptation'). Therefore, most original and key definitions for these terms were documented outside the scientific literature. Nevertheless, most terms have been adopted and were used throughout the scientific literature, which has helped to further specify them and clarify their contextual use.

The learnings from the study allow key recommendations to be made for consideration by policymakers and practitioners:

- Funding agencies are recommended to require from grant applicants a clear definition of terms that are used in their grant applications to ensure that the concept of the applicants is clearly understood. Where possible, applicants should reference authoritative definitions.
- Beyond a mere definition, grant applicants should be required to describe their proposed interventions in the context of any applicable principles or standards that potentially exist and are commonly accepted under the concerned nature-based terms (refer to **Section 4.2 Principles**, standards of forest-related NBS).
- In addition to explaining how the proposed activity adheres to recognized principles and standards, project proponents should explain how their proposed activities will lead to intended outcomes.
- Applications can be screened for the use of nature-based terms in various sections of the documents. This will help to identify whether key terms are used as mere buzz words to attract attention, or whether the concepts behind them truly determine the approach taken by applicants.
- Well-defined terms set the context for proposed actions but in terms of outcomes, principles and concepts are more important than terms. Thus, proposals should not be judged by their use (or even misuse) of terms, but by ensuring that principles and standards are met, and proposed actions clearly relate to the intended outcomes.
- Beyond simply checking boxes of compliance with applicable principles and standards, proposals should be investigated whether the concepts defined by the respective

nature-based term(s) as well as the principles and standards form integral parts of the theories-of-change of the proposed intervention. If applications are required to include theory-of-change graphical presentations, logical frameworks, including indicators, or other project management frameworks, adherence to applicable principles and standards should be reflected throughout these planning tools.

- Importantly, terms evolve over time and as these nature-based concepts become embedded in policies and programs, they take on contractual meaning. Thus, it will be important to periodically assess the use of nature-based terms, their definitions, and the concepts embedded within.
- Policymakers and practitioners are advised to keep in mind the strongly regional (e.g., ‘Forest Restoration,’ ‘Integrated Landscape Management’), land use-specific (e.g., ‘Nature-Based Solutions’), or scale-specific (e.g., ‘Integrated Landscape Approach’) connotation of certain nature-based terms.
- Remember as well that translation of these English terms and even nature-based concepts into local languages may be difficult, and vice versa – important nuance may be lost in translation when these terms are presented to non-scientist audiences.
- Terms that include a social process (intervention into social-ecological systems) are more valuable in delivering forest-related restoration targets than terms that only cover technical approaches (intervention into ecological systems only).
- A strength of FLR as a process has been the attempt to balance ecological functioning with social benefit and livelihoods, as has been demonstrated by the inclusion of participatory planning into other nature-based processes.
- A challenge going forward will be maintaining the momentum of restoring forested landscapes as the UN Decade on Ecosystem Restoration focuses attention on other ecological systems badly in need of restoration. Rather than competing initiatives, the global community could begin a dialogue on harmonizing nature-based concepts and developing guiding principles and standards that balance ecological functioning and social development.

#### **4.5 Final overall conclusion**

Adherence to a specific definition of a nature-based approach is less important than emphasizing expected outcomes in terms of improving the quality of the targeted socio-ecological system. Following the principles and standards of NBS approaches should improve the amount and quality (composition and structure) of vegetation cover, secure ecosystem services of clean water in quantity, soil and biodiversity protection, and production of products from the forest (wood volumes to be harvested, non-timber forest products, food security), and improve livelihoods in terms of income levels, improvements, and jobs.



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