

Transforming ambition into action to catalyse nature-based solutions: Insights from 250 good practice policy instruments

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ABSTRACT

Ambition to leverage the power of nature-based solutions (NbS) to address global challenges such as the interlinked climate change and biodiversity crises has reached unprecedented levels. Despite a growing consensus around the potential benefits of NbS, this ambition has not translated into sufficient actionable progress in practice. Cities, increasingly recognized as centres of transformative capacity, have become a focal point for achieving NbS ambitions. Nevertheless, the transition from theoretical discourse to practical implementation has been slow, with NbS frequently being overlooked until recently in political agendas. A key obstacle to progress is the lack of action-oriented research grounding theoretical discussions in empirical evidence on NbS policy design and application. This paper seeks to address these knowledge gaps by: (i) defining criteria for good practices in urban NbS policy design and implementation; (ii) assessing policy instruments from the Urban Governance Atlas (UGA) against these criteria using mixed statistical and qualitative methods; and (iii) identifying potential pathways and actionable measures to promote the adoption of good practices in practice. Drawing on the diverse UGA examples, with a particular focus on Europe and the CELAC region, the paper identifies seven good practice criteria and outlines four potential pathways and related actions to guide the development of NbS policy instruments across varied urban contexts. Concrete recommendations around actionable knowledge aim to tap the transformative potential of NbS in addressing pressing global issues.

1. Introduction

Ambition to leverage the power of nature to address global challenges such as the interlinked climate and biodiversity crises has reached unprecedented levels. Nature-based solutions (NbS) – defined as “actions to protect, conserve, restore, sustainably use and manage ... ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits” [1] – have been spotlighted in the context of United Nations (UN) discussions on the climate [2], biodiversity [3–5], and the Sustainable Development Goals [6] and are already included in 92 % of national climate pledges (Nationally Determined Contributions) [7]. Ministers and high-level state representatives [8,9] as well as global businesses and the private sector [10–12], the scientific community [13] and the European Commission [14–16] have called for enhanced political leadership, financing

for, and implementation of NbS at scale. Despite growing consensus around NbS’ potential benefits, however, this ambition has not translated into sufficient actionable progress in practice [17] and significant knowledge gaps persist around the embeddedness of NbS in policy, regulatory and planning schemes as well as the institutional arrangements that have been adopted to support uptake.

Cities, which are often historically regarded as contributors to environmental challenges [18], play a pivotal role in the NbS paradigm [19,20]. Although rapid urbanisation has resulted in urban sprawl, soil sealing, and densification and has created significant obstacles to reaching global sustainability goals [17], cities also possess considerable transformative capacity to slow the rate of biodiversity loss, address climate change goals, and protect urban populations and infrastructure and support a transition towards increased urban sustainability and resilience [21–23]. It is therefore vital to recognise cities as both contributors to global environmental issues and potential champions for

Abbreviations: UGA, Urban Governance Atlas; CELAC, Community of Latin America and Caribbean states; SRI, legislative, regulatory, or strategic instruments; AbCI, agreement-based or cooperative instruments; EFI, economic or fiscal instruments; KCII, knowledge, communication, and innovation instruments.

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change through the strategic deployment of NbS as critical infrastructure. In this context, the city landscape has become a focal point for incorporating nature into local urban agendas to achieve large-scale NbS implementation [23–25]. This is in line with recent EU policy developments, including the European Green Deal and its EU Biodiversity Strategy to 2030, which explicitly recognise this role and offer new opportunities for strengthened NbS investment and action [26].

Despite recognition of policy as a crucial NbS enabler [27], the transition from theoretical discourse to practical implementation has been slow [27,28]. The adoption NbS has only recently gained significant traction in political agendas [25,27,29]. Key obstacles to mainstreaming urban NbS include limited policy development, a lack of knowledge and financial resources, and challenges around collaborative governance [30,31]. Furthermore, a lack of action-oriented research that could ground theoretical discussions in real-world foundations and empirical evidence [31], or showcase lessons learned from policy design and application [27], represents a significant obstacle to progress. Related research often concentrates on definitional discussions (e.g. around mainstreaming and multi-level governance [23]), the role of municipal governments in creating opportunities and breaking down barriers for urban NbS [32–35], assessments of NbS governance [36], or on the interaction of policy-mixes [37] rather than on the policy instruments themselves and their attributes. In particular, available knowledge is characterized by diverse conceptual frameworks [23,33,38], evaluations of the barriers and deficiencies in implementing and adopting NbS [27], and examinations of their potential impacts and benefits [27,39,40].

Studies showcasing specific policy instruments being used in practice to support NbS uptake remain rare [27] and no study has carried out a systematic, large sample assessment of implemented practices. Policy instruments can be understood as the “myriad [of] techniques at the disposal of governments to implement their policy objectives” [41]. Available studies tend to make only cursory mention of these instruments in the context of encouraging NbS adoption [27]. Furthermore, they often lack consideration of other objectives such as inclusiveness, long-term sustainability, multifunctional support for NbS, and the wider effectiveness of policy instrument design and implementation [27,39]. Consequently, there is a need to gain a deeper understanding of the practical aspects of urban NbS policy, including the interpretation of ‘good practices’ within this domain, and the identification of actionable measures to promote the fulfilment of these criteria.

The term ‘good practice’ is used in this article to refer to proven methodologies or approaches that have been demonstrated to be effective in achieving desired outcomes [42,43]. In this case, the focus is on policy instruments. Rooted in the concept of policy transfer and the recognition that cities - despite their uniqueness - often face similar challenges, good practice policy instruments can facilitate the formulation of well-designed policies and serve as tools to stimulate reflection on policy decisions, facilitate learning and shape debates [42]. It is, however, important to recognise that what works well in one context may not be equally successful if replicated in another. Furthermore, NbS and the policy instruments supporting them inherently necessitate localised and context-specific approaches. It is therefore beneficial to identify criteria that can be adapted in various combinations in order to achieve desired policy outcomes based on the specific local ambitions and contexts. We posit that an improved understanding of good practices holds the potential to enhance the design and implementation of policy instruments across diverse settings [40].

Research on the topic of enabling policy instruments for NbS is largely limited in terms of thematic scope and geographic breadth. A number of scattered publications exist exploring individual cities and their NbS policy frameworks [24,25] or conducting meta-level literature reviews examining, for example, urban NbS mainstreaming, management and governance practices, and policy instruments [23,27,36,44]. However, large-scale syntheses of real-world policy instruments that bridge the theory-practice or research-implementation gap are lacking.

In addition, the research that is available appears to have a bias towards European [23,27] and North American case studies [45], with only limited evidence on the topic of policy instruments coming from the Global South [23] and the Community of Latin American and Caribbean States (CELAC) [25,44,46]. This narrow geographical scope of research presents an additional obstacle to progress in practice. As insights are often constrained to a specific set of socio-ecological and/or socio-economic contexts, the current evidence base fails to adequately contextualise diverse urban settings, thereby undermining the inclusivity of experiences and the scalability or transferability of findings more widely [25,29,47].

This paper seeks to address these knowledge gaps by: (i) defining criteria for good practices in urban NbS policy design and implementation; (ii) assessing policy instruments from the Urban Governance Atlas (UGA) against these criteria using mixed statistical and qualitative methods; and (iii) identifying potential pathways and actionable measures to promote the adoption of good practices in practice. Drawing on the diverse UGA examples, with a particular focus on Europe and the CELAC region, the paper identifies seven good practice criteria and outlines four potential pathways and related actions to guide the development of NbS policy instruments across varied urban contexts. Concrete recommendations around actionable knowledge aim to tap the transformative potential of NbS in addressing pressing global issues.

2. Materials and methods

The authors employed a mixed-method approach, comprising quantitative statistical analysis and qualitative content analysis to identify prevalent good practices and their associated actions in practice, and to showcase and explain the findings across the EU and CELAC regions (as the geographic focus areas of the UGA). First, we present our typology of policy instruments and definition of good practice criteria, which serve as an analytical framework for the identification and classification of the 250 policy instruments included in the UGA database. Subsequently, we introduce our methodology for the assessment of the sample.

2.1. Typology of policy instruments

Policy frameworks and the instruments contained therein constitute a key enabling factor for the increased uptake and impact of NbS in urban environments [27]. In the context of the Urban Governance Atlas and this paper, policy instruments are defined as tools developed or recognised by a government to implement their policies and influence the behaviour of citizens and businesses [48]. A number of typologies for the classification of policy instruments have been developed both within and beyond the field of NbS research [e.g. 29,47–49] in order to help guide discussions. These often distinguish instruments in three categories: legislative, regulatory and strategic (LRSI), economic and fiscal instruments (EFI) and soft (or supportive) [49,50,51].

Recent years have seen a notable shift by many local governments away from a heavy reliance on command-and-control regulations (LRSI) towards the utilization of a more diverse range of policy instruments, including an increased use of soft (or supportive) instruments [52,27,30]. Such instruments include, for example, voluntary and collaborative agreements, the formalisation of bottom-up initiatives and resources, and participatory financial instruments [30]. This is also reflected in NbS literature, which emphasises a shift from government to governance and the value and necessity of participatory and innovative governance approaches [52–56]. Although the outlined practices could be classified as ‘soft/supportive’, the authors and consulted experts (see section 2.3) emphasise the added value of further specifying this broad category and explicitly distinguishing between ‘agreement-based or cooperative instruments’ (AbCI) and ‘knowledge, communication, and innovation instruments’ (KCII). The final typology of policy instruments used within the UGA thus reflects this input and classifies instruments as LRSI, EFI,

AbCI or KCII (see Table 1), thereby providing visibility and enabling each to be searched for in the UGA.

2.2. Identification and definition of good practice criteria

In order to gain a deeper insight into the current good practices in urban NbS policy instruments, we employed a multi-step procedure to identify and validate a set of criteria to be used in the UGA and our analysis. First, a scoping exercise was conducted using the Science Direct Database with the objective of identifying relevant recent scientific articles published between 2019 and 2021 (responding to limited matches in test-searches predating this timeframe). The search terms used in the abstract, title or keywords included ‘nature-based solutions’ or ‘green infrastructure’ coupled with ‘policy’, ‘multifunctional’, ‘local’, ‘effective’, ‘sustainable’ or ‘innovative’. The searches yielded approximately 80,000 open access research articles in English, including some duplicates. The resultant articles were then filtered based on the inclusion in the title, abstract and keywords of ‘good practice’ or ‘policy’ or ‘instrument’ or ‘effective’ and their variations, as well as a manual screening of the titles. The exercise was not intended to be a systematic literature review, but rather indicative of current academic discourse around the good practice policy instruments in the field of NbS and to identify core criteria to be utilised in the UGA and our analysis. The identified publications were thus supplemented with a limited number of additional studies sourced from the authors’ own knowledge or through targeted recommendations from the authors’ professional research networks believed to complement the literature identified in the scoping exercise.

These processes culminated in the full-text review of a heterogeneous body of 28 scientific publications, which were predominantly empirical studies and theoretical frameworks. A manual content analysis was conducted to identify commonalities and define good practice themes across the publications, taking account of the inherent variations in

terminology and the different degrees of relevance for NbS. The exercise yielded seven good practice criteria (see Section 3.2), which were validated in an expert workshop (see Section 2.3). The criteria were subsequently used in the development of the UGA.

As a complement to this initial approach and to ensure that the seven good practice criteria were still relevant the time of writing this paper, we repeated the approach described above in 2023. This resulted in approximately 130,000 supplementary scientific publications that were considered (including duplications), and 42 additional publications that underwent full-text review. The second scoping exercise supported the original selection of criteria and did not result in any changes to the set of seven criteria already validated by the experts in 2021.

2.3. Expert validation

An online expert workshop held in October 2021 served to refine, enhance and ultimately validate the final policy instrument typology and initial set of good practice criteria proposed for the UGA. A total of twelve experts, selected from across Europe and the CELAC region, participated in the workshop. Their professional backgrounds included representation of practitioners, city administrations and policy-makers, as well as researchers and academics. This resulted in a diversity of domain knowledge encompassing a range of areas, including practical experience and technical skills across the entire NbS lifecycle, regulatory frameworks, public policy and financial instruments, evaluation and monitoring, co-creation, community engagement and transdisciplinary approaches, NbS barriers and enabling factors, vertical and horizontal collaboration in the public sector, and more.

The workshop comprised a series of interactive exercises and structured exchanges, the objective of which was to collect detailed feedback and facilitate discussion of the presented opinions as a basis for reaching consensus. This process served to enhance the scientific rigour and validate the typology of instruments and selection of best practice

Table 1
Policy instrument typology: (sub)categories and examples.

Category	Subcategory	Examples
Legislative, regulatory and strategic instruments (LRSI)	dedicated strategy or plan	NbS, green infrastructure, or green space strategy or plan
	sectoral or overarching strategy or plan	adaptation, biodiversity, circular city, smart city strategy or plan; masterplan; integrated plans
	urban planning mechanisms	spatial (zoning), infrastructure or socio-economic development plans; green space factor restrictions on development of green areas; scoring; land use plans
	standards	green public procurement standards
Knowledge, communication and innovation instruments (KCII)	communication / awareness raising	targeted educational programs; certification (labelling) or ranking; awareness raising campaigns
	knowledge and innovation	communities of practice; living labs; creating workshops; pilots; constructing business cases
Economic and fiscal instruments (EFI)	disincentives	taxes and charges/fees, tariffs; trading of permits for using a resource or trading
	payments, subsidies, incentives	subsidies or payments to landowners/ private actors for practices; public financing/grants
	financing mechanisms / market-based instruments	‘green finance’ or debt-based instruments; payments for ecosystem services (PES); public-private-partnerships (PPP)
Agreement-based or cooperative instruments (AbCI)	direct engagement of citizens / multistakeholder collaboration	citizen science programmes, participatory budgets, neighbourhood development plans, community management of green spaces on public lands, community asset transfer
	joint regional planning/ action	inter-municipal exchange platforms

criteria to be used in the UGA, and later in the analysis.

2.4. Development of the Urban Governance Atlas

The Urban Governance Atlas was developed between 2021 and 2023 as part of the EU-funded INTERLACE project, under the coordination of the Ecologic Institute and drawing on the input of 47 additional organisations. The UGA's objective is to foster ecologically coherent urban planning and decision-making for the restoration and rehabilitation of urban ecosystems. It places particular emphasis on NbS for ecosystem restoration, which are defined as (peri-)urban nature-based solutions that restore, rehabilitate and (re)connect ecosystems along the urban-rural nexus.

In accordance with the typology of policy instruments presented in Section 2.1 and the good practice criteria outlined in Section 2.2, the UGA – as the name 'Urban Governance Atlas' implies – focuses particularly on the governance structures and practices associated with each policy instrument. In this context, governance refers to the "formal and informal institutions, rules, mechanisms and processes of collective decision-making that enable stakeholders to influence and coordinate their interdependent needs and interests and their interactions with the environment at different scales" [57]. Specifically, we strove to collect information on the type of involvement of different governmental and non-governmental actor groups in the design and implementation of the respective policy instruments (for further details on the conceptual understandings employed in developing the UGA, see [48]).

The data collection process for the UGA entailed the utilisation of three primary methods: interviews, document analysis and an online questionnaire [58]. The interviews and document analysis were conducted with the dual objective of identifying relevant policy instruments and of collecting more detailed information for describing the selected policy instruments. This was done in accordance with the online questionnaire (see Table 4 in Annex A for the full questionnaire, including the typology of policy instruments). The instruments implemented in the EU and CELAC regions were the primarily targeted, as this was the geographic focus of the INTERLACE project. Consequently, all materials (e.g. the questionnaire, UGA website and guidance document) as well as the interviews were available in both English and Spanish (for further details on the process, see [48]). Open calls for contributions and knowledge sharing were conducted in English and Spanish at numerous conferences and events in Europe and the CELAC region, as well as through the INTERLACE partners' networks and social media accounts to assist in identifying potentially relevant policy instruments. Ultimately, as outlined in the UGA Guidance document [48], the included policy instruments were required to have been implemented between 1995 and 2022 and considered to satisfy at least one good practice criterion. All identified instruments which met these criteria were included in the UGA.

All policy instrument submissions were subjected to a review in their original language by native speakers on the UGA development team. This was done to guarantee the quality and clarity of the data, while ensuring that the original meaning was not altered. The finalised policy instrument entries were translated automatically using artificial intelligence into the alternative language (Spanish to English and vice versa).

Each policy instrument entry provides a succinct overview of the instrument and its general attributes, accompanied by a more detailed account of its governance, financing, and results. Additionally, it includes an examination of the overarching success factors and lessons learned across these categories (see Table 4 in Annex A for the full questionnaire). The instruments are classified according to their type and respective subcategory (see Table 1), operating within the context of a city's shared policy landscape. In light of the growing emphasis on active citizenship in NbS literature, the UGA development team made the decision from the outset of the project to include instruments that have been (1) directly initiated by governments or (2) formally recognised by governmental actors following their initiation by non-

governmental actors [48].

2.5. Analysis of policy instruments

A mixed method approach was employed to identify good practices and associated actions across the UGA policy instruments, integrating both quantitative and qualitative analyses. In particular, statistical analysis techniques, including descriptive statistics and correlation analyses, were employed across the 250 policy instruments in order to discern patterns and significant variations across the seven good practice criteria. This encompasses the identification of instances of the good practice criteria, as well as the establishment of linkages and correlations in frequency between them. The objective is to ascertain which combinations are most prevalent in the total sample of good practice policy instruments, and to determine the consistency of these patterns are consistent across regions and policy types.

Subsequently, a mixed deductive and inductive qualitative content approach was employed on a subset of 30 of the instruments (see Table 5 in Annex B) to identify actions and tools – i.e. pathways – which have been demonstrated to lead to the fulfilment of good practices. To ensure a wide coverage of the various types of good practice criteria across different policy instrument categories, 23 in-depth instruments were initially selected from the total sample based on their fulfilment of all seven criteria (eight instruments) or six of the criteria (fifteen instruments). To identify any new themes that emerged during the analysis, the textual content of this policy instrument subset was coded according to the identified criteria, using the key words and insights gained from the literature scoping exercise as a reference. Nevertheless, the analysis revealed that not all criteria were sufficiently illustrated in the instruments under examination. To provide a more comprehensive outline of robust actions for each criterion within the emergent pathways, seven additional instruments were identified as fulfilling between two and five good practice criteria. This resulted in a total of 30 policy instruments being included in the detailed review.

The discussion section provides a detailed elaboration of the results of this exercise, with each operational pathway centred around pairs of co-occurring criteria and an examination of how these have been achieved in practice. This serves to illustrate leverage points that can be exploited to improve policy design and implementation. A triangulation exercise was conducted with the reviewed literature (see Section 2.2) to develop a deeper understanding of the implementation process and to integrate the research findings with those of practice. Where appropriate, the analysis extends where notable to a comparative examination between the EU and CELAC regions, with a view to discerning region-specific distinctions.

3. Results

3.1. Overview of NbS policy instruments

The Urban Governance Atlas, which serves as the sample for this research, comprises 250 policy instruments stemming from 41 countries. While the geographic focus lies on Europe (151 instruments) and the Community of Latin American and Caribbean States (CELAC, 91 instruments), eight further instruments from other geographic regions are included in the overarching analysis to ensure completeness, while not affecting the overall emergent trends or regional EU-CELAC findings. The five countries with the highest representation are Colombia, Germany, Ecuador, the United Kingdom, and France, collectively accounting for 45 % of the instruments. The scale of implementation ranges from national to smaller entities, with the municipal scale being the most frequent (183 instruments). It should be noted that some instruments have been implemented at multiple levels or at an inter-regional/intermunicipal level. The analysis distinguishes between instruments initiated by governmental and non-governmental actors, with the former representing 82 % and the latter 18 %.

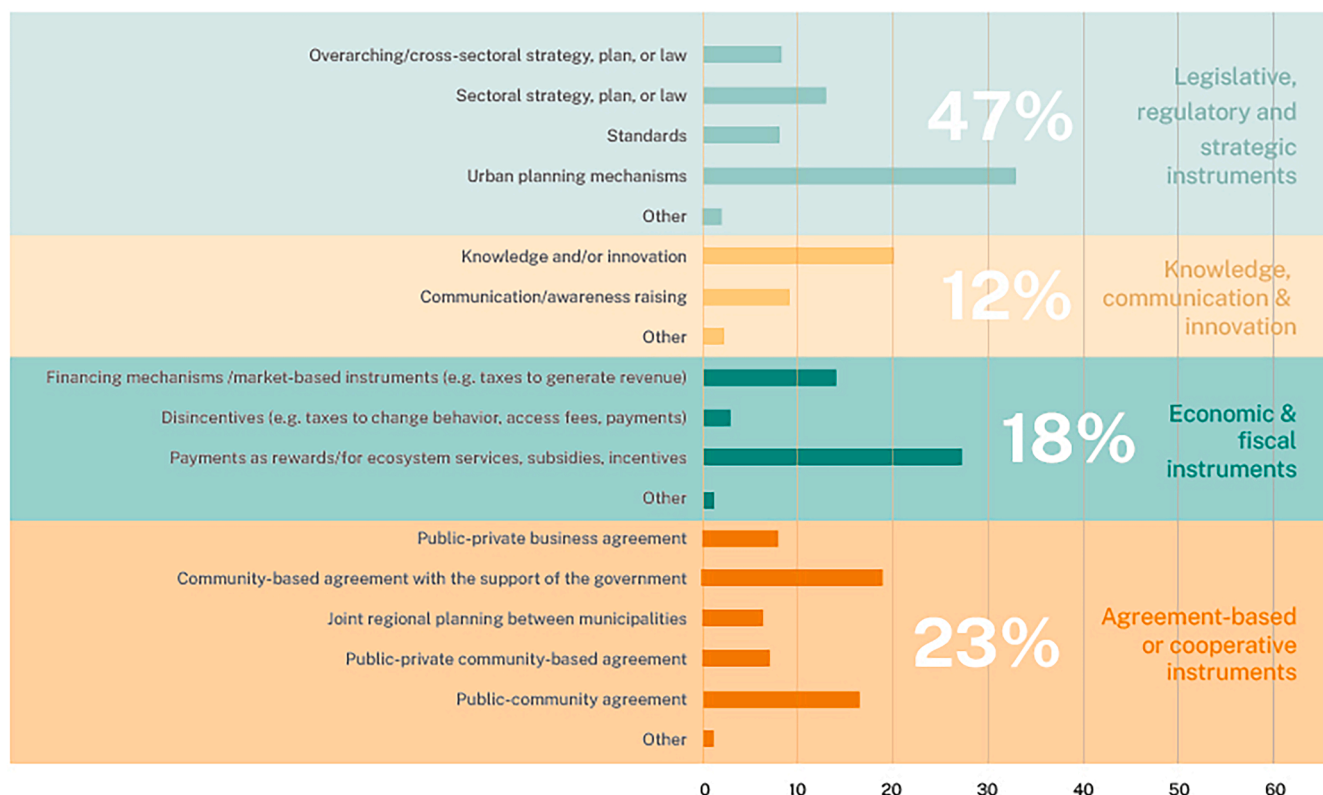


Fig. 1. Frequency of (sub)categories of policy instruments across the 250 policy instrument sample.

As illustrated in Fig. 1, the sample can be broken down as follows: 47 % legislative, regulatory, or strategic instruments (LSRI); 23 % agreement-based or cooperative instruments (AbCI); 18 % economic or fiscal instruments (EFI); and 12 % knowledge, communication, and innovation instruments (KCII). Within both the European and CELAC contexts, the most prevalent sub-types of LRSI instruments are ‘dedicated strategy, plan, or law’ and ‘urban planning mechanisms’, collectively constituting 30 % and 43 % of all instruments implemented in each region. It should be noted that the final sub-categories of instruments, as outlined in Fig. 1, differ slightly from those originally proposed in Table 1. This modification reflects an effort to enhance clarity through an optimisation process based on the results of the UGA questionnaires, which led to the merging or addition of some of the original subcategories.

The UGA indicates the areas of impact for each of the policy instruments along sixteen independent challenges. The categories were identified within the INTERLACE project through a co-creative approach between consortium partners. A total of 95 % of the instruments address at least three challenges, resulting in a figure exceeding 100 % for the total. Of the 250 instruments, 74 % have an impact on green space management, 72 % on human health, comfort, and well-being, 52 % on flood risk and soil permeability, 50 % on heat stress and heat island effect, 49 % on water management and 42 % on air quality, amongst other benefits (see Fig. 2).

3.2. Good practice criteria

Although the concept of ‘good practices’ is acknowledged in the context of NbS policy (instruments) in the reviewed literature, a consolidated framework is lacking. Furthermore, the focus is largely on the NbS themselves, rather than on the attributes of the instruments designed to foster their uptake. Moreover, the term ‘good practice’ is not consistently employed; rather, it is often referred to within the context of effectiveness.

In accordance with the methodology delineated in Section 2.2, seven good practice criteria were identified: inclusive; effective; support multifunctional NbS; sustainable in the long-term; locally appropriate; upscalable/replicable; and innovative. Of the 70 scientific publications reviewed, the criterion *locally appropriate* was most frequently addressed (96 % of articles), followed by *effective* (89 %), *support multifunctional NbS* (71 %), *innovative* (67 %), *inclusive* (65 %), *sustainable in the long-term* (60 %), and *upsalable/replicable* (39 %). The criteria are defined in Table 2 based on the literature, with some of the findings extrapolated from an NbS-focus to a policy-instrument focus. The discussion section presents a synthesis of the literature on the practical fulfillment of each criterion, integrating the implemented examples from the UGA.

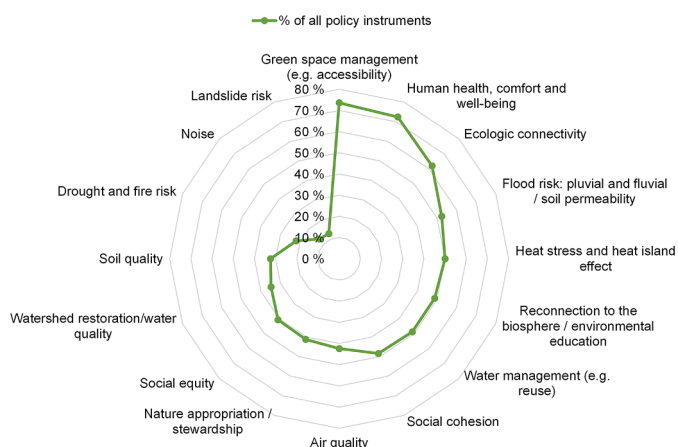


Fig. 2. Challenges addressed across the policy instruments.

Table 2
Good practice criteria and their definitions.

Good practice criteria	Definitions and examples in the literature
Effective	Ability to deliver intended benefits and address specific challenges in a given context [59–61]; provide co-benefits, such as climate adaptation and improved ecosystem services [62,63]; involves a strong design, suitable scales of implementation, and monitoring to ensure positive impacts [24,64].
Inclusive	Intentional incorporation of diverse perspectives, stakeholders, and communities in planning, design, and implementation; recognize the importance of equitable participation, social justice, and collaboration to ensure that the needs and concerns of all stakeholders are addressed [30,59,60,64–68]; aims to involve a wide range of actors, from local communities to experts, in decision-making processes, fostering resilience, social cohesion, and more effective urban development [30,59].
Innovative	The capacity to transform challenges into opportunities for creative and novel approaches, contributing to economic growth, environmental enhancement, and societal advancement [59,69,67,70]; ability to overcome barriers and harness inventive strategies to enhance functionality and contribute to more resilient and competitive economy [69,67]
Locally appropriate	Tailored to local conditions and integrating site-specific knowledge and resources [22,71]; address environmental challenges through collaborative governance, involving diverse stakeholders, including local communities [17,56], and align with the local environment and social context [72]; require citizen engagement, co-design, and responsiveness to specific socio-ecological conditions for inclusive and impactful outcomes [56,69,73]
Support multifunctional NbS	Ability to foster NbS that provide diverse benefits simultaneously, such as ecological services, climate resilience, human well-being, and socio-economic development [67,74,70,75]; involves optimizing various functions and ecosystem services within limited urban spaces to address multiple challenges effectively.
Sustainable in the long-term	Ability to endure and deliver benefits and intended effects over extended periods, considering ecological, social, and economic dimensions [7,24,35,43,47]; involves integrated planning, monitoring, maintenance, and adaptation to changing climatic conditions; supported through effective long-term management, citizen engagement, climate resilience, and consideration of local context [73,76–78]
Upscalable/ replicability	Upscaling or replicating involves experimenting and adapting designs based on local contexts [17,22,67,71,79]; landscape-scale consequences, design, scale, and governance affect replicability [22,56,80]; local adaptation, evaluation frameworks, hybrid governance, and holistic approaches contribute to successful upscaling [56,80–82]

3.3. Frequency and patterns of occurrence of good practice criteria

The occurrence of the seven good practice criteria was analysed across the total sample of 250 policy instruments as well as for the EU and CELAC regions and by policy instrument type. This was done to identify emerging trends in policy design and implementation. Overall, the most prevalent criterion is that of *locally appropriate* (84 % of all instruments), followed by the criteria of *upscaleable/replicable* (78 %), *sustainable in the long-term* and *support multifunctional NbS* (62 % each), *inclusive* (51 %), *innovative* (45 %) and *effective* (45 %). This ordinal ranking is consistent across both the EU and CELAC regions.

An examination of the four policy instrument types revealed slight divergences in the frequency of criteria fulfillment. While KCIIs (in the EU and CELAC) and EFI (in the EU) exhibited near-even fulfillment of all seven good practice criteria, the LRSI and AbCI demonstrated larger discrepancies between the fulfillment of the most and least frequent criteria. The former exhibited a greater tendency to fulfil the criteria of *upscaleable/replicable* and *locally appropriate*, while the latter demonstrated a greater tendency to fulfil the criteria of *innovative* and *effective*.

The majority of the sample (89 %) satisfy three or more good practice criteria, while eight policy instruments (3 %) satisfy all seven criteria. The figures are slightly lower in CELAC (85 %; 1 %) than in the EU (90 %; 4 %). Fig. 3 illustrates the percentage of instruments that fulfil multiple good practice criteria. The analysis of these pairings/clusters provides preliminary insights and a structured approach to the complex interactions and joint criteria occurrences across instruments. This analysis also serves as a foundation for identifying pathways that can be replicated or adapted to enhance policy design and implementation towards specific aims (see Section 4).

The three most common criterion pairings across the sample and regions fulfil the *locally appropriate* criterion, indicating a strong influence as a primary consideration in instrument design. This good practice criterion is most frequently paired with the criteria of *upscaleable/replicable* fulfillment (67 % of all instruments), as well as *support multifunctional NbS* (54 %) and *sustainable in the long-term* (53 %). While the *inclusive* and *effective* criteria were fulfilled in only a minority of instruments, these criteria are nevertheless frequently observed together with *locally appropriate* instruments in 44 % and 40 % of all cases. Regional variations were found to be insignificant, with the overarching trends observed across regions. In instances where three criteria are fulfilled, the analysis demonstrates the largest occurrence of clusters including the criteria *locally appropriate* and *upscaleable/replicable*. In

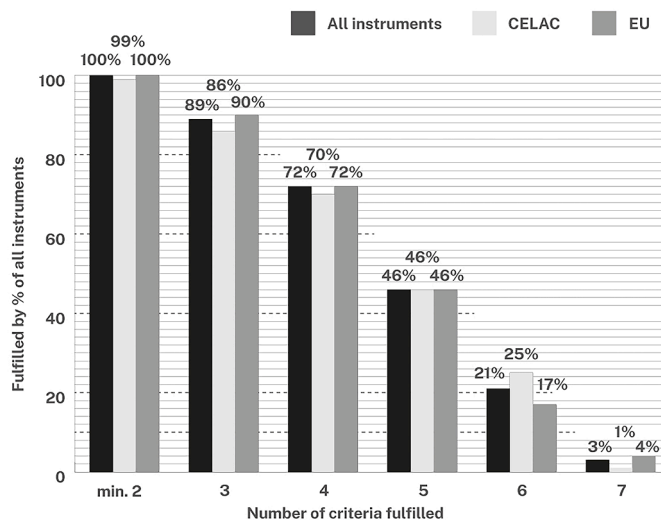


Fig. 3. Frequency of good practices fulfilled, by region.

particular, 42 % of all instruments fulfilled both of these criteria in conjunction with *sustainable in the long-term* or *support multifunctional NbS*. Approximately one-third of the instruments are *locally appropriate*, *sustainable in the long-term* and *support multifunctional NbS* or *locally appropriate* and *upscaleable/replicable* in conjunction with *inclusive*, *effective*, or *innovative*. The majority of the remaining three-criteria clusters were observed in between 18 and 29 % of instruments, with the remaining six clusters occurring in <15 % of instruments. The clustering of *effective*, *innovative*, and *inclusive* was the least frequent, occurring together in only 11 % of all policy instruments.

4. Discussion

Available literature on NbS policy instruments seldom progress beyond theoretical or site-specific discussions [27], and often focus on effectiveness as a single policy evaluation criteria. This underscores the lack of holistic frameworks available to evaluate and optimise NbS policy instruments beyond their effectiveness as well as remaining knowledge gaps around *how* to successfully design and implement instruments in practice to realise a breadth of desired outcomes.

The identified good practice criteria represent a first step towards a more comprehensive approach to NbS instrument design and evaluation, offering a flexible framework that can be tailored to different contexts and needs and serve as a common language in research and policy discourse and practice. This flexibility is integral to accommodate the strong diversity within and between the EU and CELAC regions around, for example, institutional frameworks and funding structures, traditions of engagement and participation, openness to integrate diverse forms of knowledge, and cultures of grassroots activism.

Further utility for practitioners and policy-makers is provided in this section through operational pathways, comprising available tools and action points, to answer the question of 'How?'. By integrating insights from the literature scoping exercise and case study learnings from the analysis of the 30 good practice policy instruments (referenced as 'Case X' in accordance with Table 5, Annex B; see Section 2.4 for the selection process), the good practice criteria are broken down into digestible actions. While some actions may be directly replicable or easily adapted, others are intended to inspire or stimulate local innovation in policy design and implementation.

Each pathway focuses on a pair of co-occurring good practice criteria identified in the subset. It is important to note that while all of the 30 in-depth instruments fulfil multiple good practice criteria, the criteria pairings presented in this section do not solely focus on those that are the most frequently occurring across the entire 250-instrument UGA sample (see Section 3.3). Instead, the highlighted pairs and pathways illustrate a selection of the theories which were identified in the literature as offering notable promise for improving the design and implementation of NbS policy. The pairings and their respective pathways encompass both horizontal and vertical forms of collaboration and engagement at the local and regional levels. As the four selected pathways are not yet prevalent in practice, the frequencies of each pairing within the total 250-instrument sample are provided for reference to highlight the remaining scope of opportunities for future urban NbS planning.

4.1. Multiscale governance and financial incentives to enhance long-term sustainability and potential for replicating and upscaling

Almost half of the 250 policy instruments included in the UGA (48 %) are found to fulfil both the good practice criteria *sustainable in the long-term* and *upscalable/replicable*, thus demonstrating the already common practice of considering both criteria in parallel. Nevertheless, only approximately one-third (39 %) of the reviewed articles address the issue of *upscalability/replicability*. These studies demonstrate that instruments that are scalable or replicable require a nuanced approach that integrates experimentation and adaptive design, rooted in local contexts in order to ensure the sustained delivery of ecological, social, and economic benefits over extended periods [22,79]. The fulfillment of these good practices within the 30 in-depth cases was frequently achieved by the adoption of a multiscale governance approach or the utilisation of financial incentives.

The exploration of case studies has revealed that a multiscale and hybrid (multi-actor) governance approach is a promising pathway for achieving both criteria. The cases demonstrate a variety of strategies for fostering cooperation among stakeholders at different geographic scales, including peri-urban, metropolitan, and regional levels. Such approaches are outlined in the literature as a means of achieving sustainable and upscalable outcomes that consider different scales of governance, diverse stakeholder perspectives, and the complexity of natural systems, enabling policy instruments to adapt to changing climatic and local socio-economic conditions over time [22,23,80]. In accordance with the literature, these design and implementation approaches prove effective as a knowledge exchange and capacity-building strategy, simultaneously encouraging experimentation, the adaptation of policy designs based on local contexts, and the extension of successful models to broader scales [67,79].

Examples from the literature illustrate the implementation of

regional-scale funds for policy implementation, the undertaking of large-scale projects with an emphasis on long-term goals, frequently involving the management of water ecosystems, and the utilisation of collaborative financing initiatives at the supra-municipal level [64,83,84]. The policy instruments contained in the UGA following these strategies offer further insights into these topics. Case 10, for example, established regional-scale funds and funding instruments tailored specifically for collaboration around nature-based solution projects. This example along with others (e.g. Case 12, 16) illustrates the added value of inter-municipal collaboration in the context of joint initiatives. Such collaboration allows for the pooling of resources and expertise, enabling common challenges to be addressed and shared opportunities to be capitalised on effectively.

Another insight to emerge around multiscale governance from the cases was the creation of platforms for knowledge exchange between municipalities. This was seen as a means of facilitating the sharing of best practices and lessons learned, as well as fostering a collaborative environment conducive to innovation and replication. This was exemplified in Cases 12 and 16. Furthermore, in some instances, engagement in regional networks and partnerships was undertaken with the objective of enhancing opportunities for knowledge sharing and capacity building, as well as collective action towards sustainable NbS governance. The River Contracts initiative in Flanders, Belgium provides a case in point. It enables local governments to collaborate with citizens, businesses, and associations in supra-municipal efforts through the creation of participatory river contracts. In this process, a diverse steering group is required to sign a commitment charter, and stakeholders are invited to contribute ideas both online and offline, thereby influencing the actions defined in the contract. These contracts, which are signed by the relevant parties, guarantee the continued involvement of citizens through the establishment of a consultation platform. This fosters public support, the sharing of ideas, and an increase in stakeholder engagement with regard to the implementation of local actions (Case 14).

Furthermore, financial incentives were identified as a means of achieving both longevity and replicability/upscalability as part of a forward-thinking policy approach to urban NbS. Such measures may include, for example, the design and execution of payments for ecosystem services to incentivize conservation efforts while simultaneously promoting sustainable land management practices (e.g. Case 10). Accessible subsidy programmes, which are designed to meet the specific needs of local stakeholders, can also facilitate broad participation and engagement in policy implementation. Furthermore, they can foster a sense of ownership for the implemented NbS among the local population (e.g. through monitoring or ecosystem maintenance or management). The financial instrument, the More Women, More Nature Program established in Costa Rica (Case 21) provides an illustrative example of a credit mechanisms specifically designed for NbS projects. This mechanism prioritises women involvement in NbS actions with well-defined criteria that serve to streamline access to financial resources and promote the scalability and sustainability of such initiatives.

In some cases, actions are taken which highlight the potential of collaborative frameworks based on financial incentives to achieve desired outcomes. This may be done, for example, through the use of payments for ecosystem services or accessible subsidies. The Water Fund Agua Capital in Mexico City (Case 10), for example, addresses aquifer overexploitation and related water security challenges as well as inefficiencies in payment systems and wastewater treatment. The Fund operates within the Latin American Alliance of Water Funds and exemplifies an innovative governance model that incorporates members of civil society, NGOs, the private sector and academia in the definition of key investments. Additionally, it tests novel financial mechanisms within existing institutional frameworks, such as the co-financing of actions where the local government provides initial funding, and all partners contribute to the implementation cost. The fund has had a significant impact on the political discourse surrounding water pricing,

resulting in a notable increase in investment in NbS, particularly in green infrastructure, payments for ecosystem services, and community projects. Furthermore, the fund facilitates the implementation Mexico City's Resilience Strategy, thereby fostering co-benefits in terms of disaster risk reduction and climate change adaptation goals.

4.2. Cross-sectoral collaboration in public bodies to effectively support multifunctional NbS

Policy instruments that are identified as being both *effective* and *supportive of multifunctional NbS* are seen to deliver on their primary objectives and address targeted challenges in a given context [71,70,85]. Furthermore, they are capable of delivering wider co-benefits, such as providing recreation opportunities, benefiting biodiversity [69,84], or increasing climate resilience, human well-being, or socio-economic development [74,86,87]. The simultaneous fulfillment of both good practice criteria is observed in 27 % of the 250 UGA policy instruments. One enabling pathway to achieve these criteria that emerged in the 30 in-depth cases is to foster cross-sectoral collaboration in order to overcome the often siloed structures that exist within and between public organisations. This approach supports increased coherence and alignment in policy-making principles and objectives across different sectors [88,89].

In practice, internal collaboration in municipalities can entail the formation of cross-departmental working groups (e.g. Case 12), the implementation of city-wide initiatives (e.g. Cases 8 and 11), or the allocation of funds to support NbS or ecosystem restoration (e.g. Case 10). Furthermore, inter-agency collaborations or partnerships (e.g. Case 19) can facilitate the implementation of effective policies and foster collective action for more comprehensive planning by providing support and necessary resources. The Bavarian Mountain Forest Initiative (e.g. Case 18) employs a working group comprising participants from forest offices in the Alpine region. The group's role is twofold: firstly, to provide recommendations for the practical implementation of the Initiative guidelines and secondly, to make decisions regarding local NbS actions, including silvicultural measures, tree stand rejuvenation, and protective area recreation. The objective of the working tables is to enhance local climate resilience by engaging local forest agencies in collaborative arrangements. This may entail, for example, suggesting modifications to forest subsidies in line with the initiative's objectives for climate change adaptation in private and community forests.

Further approaches, as evidenced in the reviewed cases and emphasised in the literature, focus on the importance of improved policy design, appropriate implementation scales, and rigorous monitoring frameworks as being critical for effectiveness [73,90]. In the context of cross-sectoral collaboration, this can be supported by actions such as the fostering of interdisciplinary training programmes for municipal staff (e.g. Case, 28) or the holding of regular inter-departmental meetings to facilitate communication, collaboration and foster synergies between different actor objectives as well as the prioritization of interventions in more integrated approaches to urban planning and management (e.g. Cases 5 and 15). Another potential venue for exploration is the implementation of coordinated monitoring and evaluation systems across different departments. This approach could facilitate the pooling of capacities and knowledge, thereby guiding enhancing the ability to make informed decisions and allocate resources in a more strategic manner (e.g. Case 24). The Vitoria-Gasteiz Green Belt (Case 20) exemplifies cross-sectoral collaboration in urban planning, whereby urban sustainability indicators have been integrated. This approach effectively addresses environmental conservation, human well-being, and flood risk mitigation, thereby demonstrating the existence of synergies between different sectors. This policy instrument incorporates robust monitoring

and evaluation systems, showcasing collaborative efforts to achieve overarching city-wide policy goals.; ocal citizen and stakeholder engagement to achieve inclusive and locally appropriate policy instruments

For NbS policy instruments to embody *inclusivity* and *effectively respond to local conditions and contexts* (e.g. environmental, socio-economic, cultural), the literature and implemented cases highlight citizen engagement, co-creation, and trust building as fundamental enablers [22,56,69,71–73]. Such processes have been the subject of considerable study in the literature with regard to their potential to not only build trust between government entities and civil society [56], but also to communicate the benefits, build awareness, and ensure that policy responses are accepted through their alignment with local needs [71]. Nevertheless, studies have also highlighted the diverse spectrum of stakeholder engagement types and degrees [16], as well as inequalities of access to decision-making processes, which in turn affect the achievement of truly equitable participation and social justice outcomes [23,75,80,85]. It is notable that approximately 38 % of the 250 policy instruments meet both criteria, which is a significant finding given that only 51 % of the 250 instruments are *inclusive*. This suggests that majority of *inclusive* instruments were also *locally appropriate*.

The 30 instruments which were subjected to a more detailed examination were found to utilise a diverse array of engagement, co-creation and feedback approaches to tailor the instruments and the NbS they support to align with specific spatial, socio-economic and cultural contexts. A common strategy is the organisation of participatory design workshops, which bring together citizens, stakeholders, and experts with the objective of co-creating policy and planning decisions (see, for example, Cases 3, 14, and 16 in Table 5, Annex B). This can facilitate what is referred to as 'deep participation', whereby local, expert and tacit knowledge is brought together to address complex urban problems in an inclusive manner [17]. Alternative participatory mechanisms include the establishment of platforms to enable continuous dialogues and facilitate communication channels, such as community forums and digital spaces (e.g. Cases 6 and 23). The Lisbon Urban Allotment Garden Programme in Portugal (Case 17) is an illustrative example of a dedicated plan to repurpose vacant spaces across the city into urban allotment parks. The process was designed and implemented with the active involvement of the local community, utilising participatory citizen platforms, participatory budget mechanisms, citizen training on organic and permaculture practices, and the co-design of spaces (e.g. the delegation of plots for recreation and the promotion of cultural activities). The platforms facilitate collective decision-making, oversee the upkeep of the gardens, and advance social justice outcomes by ensuring access to the plots for individuals facing challenges, including unemployment, advanced age, and low-income.

The implementation of tailored outreach programs, designed to engage with vulnerable, under-represented or marginalised groups, has in some cases facilitated the integration of underrepresented voices into policy decisions, in accordance with local needs [97]. In other cases, citizen surveys and feedback mechanisms were employed as a complementary approach by other cases to enhance social inclusivity and reach different actors than those participating in more elaborate in-person participatory processes, which sometimes demand more time than individuals have available (e.g. Case 24). The Berlin Neighbourhood Management programme targets disadvantaged urban neighbourhoods, with the objective of fostering the development of green spaces through community-driven initiatives. The programme establishes neighbourhood committees and councils, which are composed of elected residents, institutional representatives, and development partners. These bodies are responsible for the allocation of project funding, the shaping of long-term development goals, and the provision of support for short-term actions through an action fund jury. The neighbourhood management

team assumes a central coordinating function. This example demonstrates one approach by which municipalities can acknowledge or formalise grassroots or bottom-up initiatives and integrate local knowledge into policy development through community-led initiatives, thereby enriching decision-making processes with context-specific insights (Case 22).

The establishment of robust frameworks for cooperation among local civil society organisations, local politics, and public administration have been demonstrated to be beneficial in some cases for the implementation of policy instruments. This comes as a result of ensuring the active involvement of diverse stakeholders in the design and/or implementation of policy instruments (as evidenced by Cases 7, 9, and 25). The Water Basin Committees in Paraná, Argentina (Case 12) were originally established as a citizen's initiative, but subsequently evolved into a dedicated municipal strategy, exemplifying a comprehensive approach. The committees are structured in an inclusive manner, with both a technical segment and a citizen coordination segment. This design responds to the demands of residents, formulates public policies, and establishes a management framework. The regular convening of joint meetings has been identified as an effective means to foster productive collaboration between the two branches.

4.3. New forms of innovative collaboration for effective policy implementation

The concept of innovation in NbS policy instruments is understood in the academic literature as a means of transforming challenges into opportunities through the application of creative and novel approaches [71,70]. This, in turn, contributes to economic growth, environmental enhancement, and/or societal well-being. The criterion *innovative* is fulfilled in only 21 % of the 250 UGA cases in conjunction with effectiveness (as defined in Section 4.2). The reviewed articles posit that the limited adoption of such approaches may be attributable to structural factors, including dominant policy or funding mechanisms, prevailing knowledge paradigms or the vested interests of actor networks [64]. One potential pathway identified in the 30 in-depth cases for supporting the achievement of both criteria is the implementation of novel collaborative strategies that engage diverse stakeholders. A variety of avenues for action in support of innovative and effective policies exist, such as the formation of public-private partnerships, the implementation of citizen science, the inclusion of artistic and cultural activities, and the engagement of citizens in monitoring.

The formation of public-private partnerships can function as a collaborative framework that facilitates the engagement of diverse stakeholders with clearly defined roles and established decision-making processes. This has been demonstrated to enhance collaboration between government entities and the private sector, while also enabling the leveraging of resources and expertise for more effective and sustainable policy implementation (e.g. Case 26). In some cases, innovation is evidenced by the introduction of novel resource mobilisation methods. An example is London's Greening the Business Improvements Districts programme (Case 29), which demonstrates a creative blend of local authorities and public-private collaboration with the objective of bolstering green infrastructure. The programme, which is led by the Greater London Authority and in association with Cross River Partnership (a public-private alliance), collaborates with sixteen Business Improvement Districts (BID) on green infrastructure audits and demonstration projects, including the installation of green roofs and rain gardens. This initiative aligns with the 2008 London Plan, which was the first to integrate green infrastructure concepts into urban policymaking. The programme's partial funding for NbS incentivises BIDs, thereby advancing urban greening and heightening awareness of its benefits among residents and businesses.

Innovation around citizen engagement offers a further promising avenue towards increased policy effectiveness [17]. By initiating novel forms of public engagement – e.g. citizen-led groups - and providing the necessary training and resources, municipalities can utilise diverse applications of citizen science to empower individuals to contribute to environmental monitoring and research efforts (e.g. Cases 4 and 25). The examined cases demonstrate an enhancement in policy instrument design and implementation through the generation of a more robust evidence basis upon which to make decisions. Additionally, the literature also emphasises the potential for enhancing transparency and accountability [16]. The Aarhus City Council's 2009 initiative (Case 26) is an illustrative example of this approach. It involved an open competition to repurpose a former parking lot (Bishorvet Square) and transform it into an attractive and versatile space. In collaboration with a design studio, the city council engaged the square's neighbours and citizens in the transformation process over several years. Adaptations were made as needed in response to requests and concerns that emerged from citizen-based dialogues, with the goal of ultimately reaching a permanent transformation. The ideation phase involved close collaboration with various stakeholders, including workshops with neighbours and shop owners, which resulted in the collective vision for a multi-functional green space that could accommodate various sized events.

Educational programmes and citizen laboratories in schools and community centres represent additional avenues for cultivating environmental stewardship and facilitating experiential learning, while also enhancing awareness and understanding amongst stakeholders. The "Parques Vivos" initiative in Paraguay (Case 28) provides an illustrative example. Here, central and local government officials were trained in sustainable public space management and integrated educational elements focusing on NbS. These individuals then served as multipliers to increase impact through the incorporation of additional stakeholders in a series of events, including citizen laboratories with neighbourhood commissions, urban collectives, civil society organisations, and individuals from various regions across the country.

Finally, the integration of artistic and cultural events into NbS awareness-raising campaigns (classified as 'knowledge, communication and innovation instruments') has the potential to enhance public outreach and foster a deeper connection and sense of ownership of urban green spaces among diverse communities. In Case 30, for instance, the London National Park City campaign represents a grassroots movement that underscores the city as an ecosystem that is worthy of protection. The campaign, in collaboration with local government entities, was able to secure political backing and successfully designate London as the world's first National Park City in 2019. The campaign's primary objective is to make London greener, healthier, and wilder. To this end, it engages communities through a range of activities, thereby fostering a collective identity as a National Park City. The Mayor of London endorsed this concept in the 2018 London Environment Strategy.

4.4. Potential limitations

Despite the robust methodology applied in collecting the 250 policy instruments, several limitations are evident. First, the intention of the UGA was to collect and present a broad range of good practice policy instruments from a variety of countries in the world, primarily in Europe and the CELAC, with the objective of inspiring wider municipal action for NbS. It was not, however, intended to be an exhaustive database. Data thus might have a bias towards certain countries or instruments that have more easily accessible or extensive data; nevertheless, some instruments have data gaps. Additionally, the information provided for each policy instrument was provided by a large group of experts whose responses may have been influenced by different opinions or

understandings of the good practice criteria. In addition, the scoping exercise conducted to define good practice criteria was intended to be indicative, but not comprehensive as a systematic literature review would be. Furthermore, the actionable insights reflect findings from the subset of 30 instruments and do not reflect the full breadth of policy instruments included in the UGA. The insights are sometimes limited by the depth of detail that the respective policy instrument authors originally submitted. The types of policy instruments included in the subset were not subjected to the same level of scrutiny as the criteria they fulfilled, which may have resulted in a potential gap in the coverage across (sub)categories of instruments. Ultimately, the focus of the UGA and thus this study lies on government-driven or formally recognized instruments and thus neglects the analysis of short-term / bottom-up instruments that lack formal governmental recognition. These informal initiatives represent an important element of NbS governance and in catalyzing change at the local level. Such initiatives often operate on a smaller scale and may not adhere to traditional policy structures or formal governance mechanisms. Nevertheless, they can offer valuable insights in support of NbS.

5. Conclusion

This article provides a robust empirical foundation to support the academic community and policymakers in moving beyond theoretical discussions in pursuit of evidence-based strategies for improved design and implementation of NbS policy instruments. Our analysis has synthesised a selection of the scattered literature on good practices in this domain into a singular framework of seven key criteria, integrating considerations from the literature and contributing to a shared understanding and foundation for future research and action. The most frequently occurring pairs and clusters of good practice criteria are identified in order to gain insights into the extent to which current practice fulfills these criteria and to identify potential areas for optimising the design and implementation of NbS policy instruments. A selection of the pairings is explored in greater depth based on 30 comprehensive policy instrument evaluations, which reveal four pathways and numerous actions that enable policymakers, researchers, and practitioners to support the fulfilment of good practice criteria in their local contexts.

The inclusion of the CELAC region alongside European and other cases represents a significant advance, filling an important gap in current NbS research. It offers a more inclusive perspective on potential opportunities and effective strategies that can be applied in the policy landscape. Moreover, the geographic diversity of the instruments included in the analysis broadens the applicability of our findings and positions this study as a foundational resource for informing NbS policy development and research in broader geographical settings, it is acknowledged that certain principles transcend regional idiosyncrasies.

We emphasise the need to consider these good practice criteria in the design and implementation of NbS policy instruments, with due consideration given to specific local goals and ambitions. It is not our intention to propose a universal approach that would require every policy instrument to fulfill all of the criteria. Rather, we aim to provide a range of potential pathways and tested actions that can be adapted to diverse contexts, while acknowledging the uniqueness of each city's policy and wider ambitions. It is our hope that this study will spark a

dialogue on the potential applicability of these findings to regions beyond the EU and CELAC. We encourage the critical assessment and adaption of the identified good practice criteria to reflect supplementary evidence from further NbS policy instruments and advancements in scientific research.

We see the potential for further studies to build on our analysis and extract additional insights from across the 250 policy instruments included in the UGA on the basis of the good practice clusters. This would enable us to learn even more about associated actions and opportunities in practice. In particular, targeted investigations into the potential hierarchies or interdependencies between the criteria would be of interest, as would a more comprehensive analysis of the commonalities or the differences between the (sub)types of policy instruments. A supplementary review focusing specifically on informal policy instruments that have not been formally recognised by governments would also be valuable. This could recognise the complementarity of these instruments to government-led or government-formalised instruments (in accordance with the criteria of inclusion in the UGA) within urban arenas. As a result of this process, further good practice criteria may emerge, which could serve to further enhance NbS governance, both within and beyond urban areas. It is therefore our intention that our findings should not be regarded as definitive solutions applicable only to specific regions, nor as 'all or nothing' criteria. Rather, we see them as a catalyst for further discussion and action, with a view to optimising the delivery of NbS ambitions through more informed policy decisions.

CRedit authorship contribution statement

McKenna Davis: Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Natalia B. Cuevas:** Writing – original draft, Investigation, Formal analysis, Conceptualization. **Maren H. Gvein:** Writing – original draft, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Annex A

Table 4
Urban governance atlas questionnaire.

Section	Heading	Subheading	Additional text to describe the subheading	Answer categories
1. Overview of instrument	Location and description of instrument	Name of the instrument		<ul style="list-style-type: none"> • EU • CELAC • North America • Sub-Saharan Africa • Middle East and North Africa • Asia • Oceania
		Region		
		Country		
		City		
		City population		
		Scale of implementation	At what scale was the instrument implemented? (<i>multiple options possible</i>)	
	Timeline	What year did the instrument come into force/start and until what year was/is it foreseen to run?	XXXX until XXXX	
	Short description of the instrument	Briefly describe the instrument and try to answer the questions: What is it? What does it do? How does it do it?, focusing on NBS and - where relevant - ecosystem restoration. Please be sure to include the: name and type of instrument and how the instrument fits into the policy framework (e.g. a subsidy is the instrument explored, which is part of XX policy); location and scale of implementation (city-wide/national/local level); in what way the instrument supports NBS and - where relevant - ecosystem restoration; what makes it a good practice...		
	Type of instrument	Select one bold category and one subcategory (from the relevant bullet list)	<p>Legislative, regulatory and strategic instruments</p> <ul style="list-style-type: none"> • Dedicated strategy or plan • Sectoral strategy or plan • Overarching/cross-sectoral strategy or plan • Urban planning mechanisms • Standards • Other, please specify <p>Economic and fiscal instruments</p> <ul style="list-style-type: none"> • Disincentives (e.g. taxes to change behavior, access fees, payments) • Payments as rewards/for ecosystem services, subsidies, incentives • Financing mechanisms /market-based instruments (e.g. taxes to generate revenue) • Other, please specify <p>Agreement-based or cooperative instrument</p> <ul style="list-style-type: none"> • Community-based agreement with the support of the government • Private business agreement with the support of the government • Public-community agreement • Public-private business agreement • Public-private community-based agreement • Joint regional planning between municipalities • Other, please specify <p>Knowledge, communication and innovation instruments</p>	

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Table 4 (continued)

Section	Heading	Subheading	Additional text to describe the subheading	Answer categories
	Aim/Objectives	Challenges addressed	<p>What challenge(s) are/were addressed by the instrument? <i>(multiple options possible)</i></p> <p>Please select the challenges that the policy instrument implementation aims to address while fostering the implementation of Nature based Solutions.</p>	<ul style="list-style-type: none"> • Communication/awareness raising • Knowledge and/or innovation • Other, please specify • Ecologic connectivity • Soil quality • Water management (e.g. reuse) • Green space management (e.g. accessibility) • Watershed restoration/water quality • Drought and fire risk • Flood risk: pluvial and fluvial / soil permeability • Heat stress and heat island effect • Landslide risk • Air quality • Noise • Social cohesion • Social equity • Nature appropriation / stewardship • Reconnection to the biosphere / environmental education • Human health, comfort and well-being • Other, please specify
		Relation to NBS and ecosystem restoration	<p>Does the instrument explicitly target ecosystem restoration?</p> <p>If yes, please briefly describe how the instrument addresses restoration (e.g. in its aims and objectives, through targeted funding, as a central theme throughout, etc.). What type of ecosystem restoration is targeted (e.g. improving the condition of an ecosystem or re-creating or re-establishing an ecosystem that was lost)?</p> <p>What impact does the instrument aim to achieve regarding NBS (or related concepts)? What specific aims/objectives/targets were set? Outline both qualitative (e.g. increasing societal awareness of NBS) and quantitative (e.g. planting X number of trees or restoring X km of degraded river) goals.</p>	<ul style="list-style-type: none"> • Yes • No
		Relevance to specific (peri-)urban area(s)	<p>What type(s) of (peri-)urban areas are targeted by the instrument?</p>	<ul style="list-style-type: none"> • Parks and (semi)natural urban green areas • Allotments, community gardens or agricultural areas • Blue areas • Green areas for water management • Derelict areas • External building greens • Urban green space connected to grey infrastructure • Other • No specific NBS types specified
2. Governance and financing	Governance	Initiating body	<ul style="list-style-type: none"> • Government body/bodies <p>Please specify the type of government authority or authorities that initiated the instrument (e.g. ministry, specific department within an agency, public agency, local authority on...), also indicating at what scale.</p>	
		Instrument design	<p>Explain the mechanisms of horizontal or vertical collaboration in designing the instrument, where relevant (i.e. between local departments/offices, or between local and regional or local and national bodies)</p> <p>Were non-governmental actors involved in the design of the instrument?</p> <p>If yes, which types of actors? <i>(multiple options possible)</i></p> <p>How were these actors involved in the design process of the instrument? <i>(multiple options possible)</i></p>	<p>Yes/No</p> <ul style="list-style-type: none"> • Public sector institution (e.g. school or hospital) • Private sector, corporate, business • Researchers, university • Citizens or community groups / NGOs • Coalition, please specify • Other, please specify • Unknown • Co-planning or co-design of instrument (e.g. boards, advisory role)

(continued on next page)

Table 4 (continued)

Section	Heading	Subheading	Additional text to describe the subheading	Answer categories
				<ul style="list-style-type: none"> • Expert task force consultation • Civil society consultation through e.g. workshops, surveys • Other, please specify • Unknown
		Targeted actors	<p>Please include further details on the specifics of the design process, e.g. What power or role did the non-governmental actors have in designing the instrument and making decisions? What is their relation to the governmental bodies? How transparent and inclusive were decision-making processes? Was participation truly collaborative or more consultative? To what extent does the instrument reflect local needs? Is there room to adapt the instrument over time to reflect changing public needs/priorities?</p> <p>What actors is the instrument targeting? Who's decisions is the instrument aimed at changing? (multiple options possible)</p>	<ul style="list-style-type: none"> • Public sector institution (e.g. school or hospital) • Private: household, real estate developer, business, financial • Researchers, university • Citizens or community groups (CBOs), NGOs • Coalition, please specify • Other, please specify • Unknown
		Instrument implementation	<p>Were non-governmental actors involved in the implementation of the instrument, including e.g. monitoring, maintenance, spending funds, etc.? If yes, how? (multiple options possible)</p>	<p>Yes/No</p> <ul style="list-style-type: none"> • Citizen councils or consultation for co-planning (e.g. workshops, surveys) • Citizen oversight (e.g. boards, advisory role) • Co-design of NBS, implemented by government • Implementation of NBS (e.g. with government funds) • Citizen monitoring and review • Citizen science • Other, please specify • Unknown
	Financing	Source(s) of funding	<p>Please include further details on the specifics of the public's role in implementing the instrument, e.g. What power or role do/did the non-governmental actors have in implementation and decision-making processes? What is their relation to the governmental bodies? How transparent and inclusive are decision-making processes? Is public participation collaborative and consistent, or rather punctual and only for specific contributions?</p> <p>What are/were the financing source(s) of the instrument? If needed it is possible to choose multiple options</p>	<ul style="list-style-type: none"> • Public national budget • Public regional budget • Public local authority's budget • Corporate investment • Funds provided by non-governmental organization • Private Foundation • Crowd-sourcing • Other, please specify • Unknown
		Budget / total cost	<p>What is/was the total cost/budget (EUR) of the instrument? Is there a budget for the policy instrument? If yes, please provide an approximate amount.</p>	<p>Select from a range of options, e.g.</p> <ul style="list-style-type: none"> • <50 000 € • 50 000€ - 100 000€ • 100 000 € 500 000€ • 500 000 € - 1 000 000€ • 1 000 000€ - 5 000 000€ • 5 000 000€ - 10 000 000€ • above 10 000 000€ • unknown
		Financing details	<p>Please provide a brief description including further details, explanations or interesting information about the sources of funding and the total budget/cost.</p>	
3. Results, success factors, and lessons learned	Results	Achieved outcomes and impacts	<p>What outcomes or impacts have been achieved directly relating to the implementation of NBS/ecosystem restoration? What further impacts or outcomes have been achieved indirectly relating to NBS (e.g. awareness raising, collaboration of new actors together, etc.). Please provide both qualitative (e.g. increasing societal awareness of NBS) and quantitative (e.g. planting X number of trees or</p>	

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Table 4 (continued)

Section	Heading	Subheading	Additional text to describe the subheading	Answer categories
4. Related instruments (policy mix)	Good practice characteristics	Monitoring	restoring X km of degraded river) impacts. Where possible, link to the challenges addressed (see Section 1. Question: challenges). Is there a monitoring framework in place for the instrument itself? If so, please provide more information and - where possible - a link. (e.g. Who takes part in the monitoring? How often is it conducted? What aspects are monitored?)	<ul style="list-style-type: none"> • Yes • No <p><i>If yes, please provide more information and - where possible - a link.</i></p>
		Evaluation	Is an evaluation of the instrument planned or completed for the instrument? If so, please provide more information and - where possible - a link. (e.g. Who conducts the evaluation / is it outsourced? What aspects are evaluated?)	<ul style="list-style-type: none"> • Yes • No <p><i>If yes, please provide more information and - where possible - a link.</i></p>
			Which aspects of the instrument can be considered as good practice? (<i>multiple options possible</i>)	<ul style="list-style-type: none"> • Effective • Inclusive • Support multifunctional NBS • Sustainable in the long-term • Locally appropriate • Potential to be replicated / upscaled • Innovative • Policy business case • Other, please specify • Unknown
	Success factors and lessons learned		What were the key elements of success for the instrument in achieving its objectives (e.g. design of the instrument, implementation factors like cooperation, contextual factors like political support, etc.)? What insights were learned from failures or by overcoming challenges? What are key takeaway messages or recommendations for implementing such an instrument elsewhere?	
5. Sources and further information	Integration in wider policy framework		Please briefly describe how this instrument is integrated within the wider legal framework of the city or region to which it applies and its relation to key other instruments. (e.g. if a communication strategy is the instrument, describe the policy or other initiative to which it belongs; if the instrument is a task force, explain the policy or other instrument which it supports).	
	Related instruments		Which instruments in the UGA are directly related to this instrument? (e.g. communication strategy and funding instrument as part of an overarching policy; stakeholder engagement instrument as part of an awareness raising campaign)	
5. Sources and further information	References	List of references used for data collection	Please provide all references used for the data collection In Harvard style, including e.g.: PUBLICATIONS: Last name, First initial. (Year published). Title. Edition. (<i>Only include the edition if it is not the first edition</i>) City published: Publisher, Page. WEBSITES: Author surname, First initial or Organisation. (Year) Page Title. Available at: URL (Accessed: Day Month Year).	
		Interview(s)	What institutions were interviewed and used to fill out this questionnaire? Please list the institution and department, if relevant.	
	Additional information	Further weblinks and documents relevant to the instrument Photo	Please provide web links to e.g. related information sources, instrument documentation, guidance, documents, including a link to the initiating/implementing body or bodies. Please upload a photo relevant to the instrument. Please cite the photo credit as: @X.XXXX (first initial of the first name and the last name of the photographer)	

Annex B

Table 5
Policy instruments included in the in-depth analysis and good practice criteria fulfilled.

#	Name of the instrument	Country	Type of instrument	Good practice criteria fulfilled*
1	Green Corridor for the Seventh Avenue in Bogotá	Colombia	KCII	1,3,4,5,6,7
2	Dublin City Development Plan 2016–2022	Ireland	LRSI	2,3,4,5
3	Tempelhofer Feld development and maintenance plan - Berlin	Germany	AbCI	2,3,4,5
4	Programme Youth for the environment in Quibdó	Colombia	KCII	1,3,4,5,6,7
5	Ordinance N°026/2020 on the establishment of municipal conservation and sustainable use areas in the Cantón Loja	Ecuador	LRSI	1,3,4,5,6,7
6	Medellín River Parks Strategy	Colombia	LRSI	2,3,4,5,6,7
7	Use of urban trees to mitigate climate change and improve human nutrition	Venezuela	LRSI	1,2,3,4,5,6
8	Bogota Climate Action Plan - Nature-based Solutions Component	Colombia	LRSI	2,3,4,5,6,7
9	Participatory Budgeting in Cuenca	Ecuador	AbCI	1,2,4,5,6,7
10	Fondo Agua Capital - Ciudad de México	Mexico	EFI	1,3,4,5,6,7
11	Barcelona Nature Plan 2021–2030	Spain	LRSI	1,2,3,4,5,7
12	Paraná's Water Basin Committees	Argentina	LRSI	1,2,4,5,6,7
13	Sheffield Waterways Strategy	United Kingdom	LRSI	1,2,3,4,5,6
14	River contracts - Flanders	Belgium	AbCI	1,2,4,5,6
15	Emscher Landscape Park Master Plan - Ruhrgebiet	Germany	AbCI	1,3,4,5,6,7
16	The Aquifer Partnership - Brighton and Hove	United Kingdom	AbCI	1,2,3,4,5,6
17	Urban Allotment Garden Programme - Lisbon	Portugal	LRSI	1,2,3,4,5,6,7
18	Bavarian Mountain Forest Initiative	Germany	LRSI	2,4,5,6,7
19	Greening Hannover - Hannover	Germany	EFI	1,2,3,4,5,6,7
20	Vitoria-Gasteiz Green Belt	Spain	LRSI	1,2,3,4,5,6,7
21	More Women more Nature Program	Costa Rica	EFI	1,2,3,4,5,6,7
22	Neighborhood Management - Berlin	Germany	AbCI	1,2,3,4,5,6,7
23	Map of opportunities and city safari - Breda	Netherlands	KCII	1,2,3,4,5,6,7
24	River Congost River Stewardship Agreement between the Catalan Water Agency and the City Councils of Canovelles, Les Franqueses del Vallès and Granollers	Spain	AbCI	1,2,3,4,5,6,7
25	Guardians of the hills of Portoviejo	Ecuador	LRSI	1,4,5,6
26	Co-design of public square restoration - Aarhus	Denmark	AbCI	1,3,4,5,6,7
27	Public-private partnership to redevelop the Zorrotzaurre district - Bilbao	Spain	AbCI	1,5
28	Living parks laboratory - Asunción	Paraguay	LRSI	5,6
29	The London Urban Forest Partnership	United Kingdom	AbCI	1,3,4,5,6,7
30	National Park City campaign - London	United Kingdom	KCII	1,2,3,4,5,6,7

*Good practice criteria coding: 1 – Inclusive; 2 – Effective; 3 – Support multifunctional NbS; 4 – Sustainable in the long-term; 5 – Locally appropriate; 6 – Upscalable / replicable; 7 – Innovative.

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