

## NATURE-BASED SOLUTIONS - A BRIEF OVERVIEW OF THE PERSPECTIVE OF THE CITIES IN THE LIGHT OF CLIMATE CHANGE

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**Abstract:** *Nature-Based Solutions (NBS) are playing an increasingly important role in helping cities to mitigate the effects of climate change and significantly increase their resilience through the promotion of green and blue infrastructure. This study analyzed 38 articles on nature-based solutions with a direct focus on climate change mitigation and adaptation in the urban environment, targeting European cities. The aim of the review was to systematically analyse the nature-based solutions for adapting to and mitigating the effects of climate change in the selected articles, revealing the diversity of issues explored, the approaches and solutions proposed in different concrete applications, and the challenges that currently exist in reconciling cities and nature. The results of the analysis also show that, despite the large number of studies carried out at the urban level, the practical approaches of the NBS focus on one city or groups of cities that generally face similar challenges: urban heat islands, stormwater management, green areas, tested and implemented green infrastructure (GI) solutions, blue-green infrastructure. We found that ecosystem-based adaptation in the urban context is fragmented due to the different urban challenges: mainly flooding or heat and the corresponding risk reduction solutions: wetlands, green spaces, trees, parks. A key finding of the articles analyzed the involvement of stakeholders in urban and NBS planning. A more in-depth analysis and systematization of good practices at the level of urban areas can be achieved by analyzing the entire literature in the field of NBS and climate change mitigation and adaptation, categorized according to different themes, through a multidisciplinary effort.*

**Keywords:** *Nature-based solutions, climate change, mitigation, adaptation, review*

### INTRODUCTION

Ecosystems and biodiversity are inextricably linked to Climate Change (CC). Their relationship with human society is also closely intertwined. The effects of imbalances caused by human activity are nowhere more visible than in the urban environment, which is becoming ever larger, more anthropized and more polluted. The impact of human activity on the urban environment is reflected not only at the level of cities, but also beyond them. Deforestation reduces carbon storage capacity, biodiversity is lost, corridors for animals are disrupted, and the degree of shading of the ground is significantly reduced, affecting soil, flora and fauna. Under such conditions, human health and well-being are ultimately affected because the Ecosystem Services (ES) provided by nature cannot be quantified. Ecological systems have the capacity to adapt naturally, as evidenced by the evolution of terrestrial species, but we need to emphasize that the risk of biodiversity loss is real, in particular because of being exposed to the effects of drastic CC recorded over short periods of time.

From the perspective of human well-being, NBS is the way to reduce the risk of exposure to the dangers posed by climate change and to improve the environment. Thus, NBS are pillars of adaptation to the effects of CC by utilizing all the benefits that nature provides in the urban environment, both at the level of ecosystems, biodiversity, human well-being and the

urban landscape approach. The importance of NBS and the benefits they provide are highlighted in this article through a brief analysis, which aims to provide an argument for local authorities and decision-makers to include NBS in environmental strategies related to CC.

Green spaces in the urban environment have many roles to play in the urban environment: reduction of the Urban Heat Island (UHI) effect through shading, reduction of wind speed, evapotranspiration, providing a "home" for biodiversity, as well as the capacity to retention of rainwater. In addition, ES provide the opportunity to spend time outdoors, improving air quality, including by capturing dust particles from the air, reconnecting modern man with nature - are other arguments that respond to the challenge of the climate emergency.

Although the implementation of actions related to NBS is relatively new, being understood as a set of activities that contribute to the sustainable management and restoration of affected or deeply modified urban spaces, the concept of NBS has developed by dedicating solutions to ecosystems to reduce the risk of natural disasters, biodiversity and ecosystem services for the well-being of the population, thus structuring a concept that incorporates NSB, that of Ecosystem-Based Adaptation (EBA). Providing a series of multiple benefits and the recognition that nature-based solutions enjoy, in this article we will conduct a brief analysis of the specialized literature dedicated to the urban environment.

#### **MATERIAL AND METHODS**

In a first phase, we carried out a mapping of the specialized literature using only the Scopus database (last accessed on 08/05/2023), aware of the fact that relevant research may be lost, but this was a risk accepted, determined by the fact that the established objective was to make a short review. The literature covered is peer-reviewed and open access.

The Scopus database was queried using the following keywords to select literature "nature-based solutions" and "climate change" from the title/abstract/keywords, targeting articles, reviews, conference papers and conference reviews from the years 2015-2023. Filtering was continued by restricting to the subdomains' "environment" and "social sciences" using the keywords "climate change", "nature-based solutions", "biodiversity" and "sustainable development". The area covered by the articles is the European Union - 28 Member States (MS) and the MS of the European Economic Area. The selected literature was then narrowed down to the original language, English, and to the final publication status. This stage of selection produced a total of 529 results. The evolution of the selected articles on the selected keywords "nature-based solutions" and "climate change" over the period 2015 to 2023 shows a constant growth (Figure 1), which reflects the importance of this topic in research.

The three subject areas covered by the articles are as follows: Environmental Sciences (487 papers), Social Sciences (238 papers), Energy (125 papers) and Agricultural and Biological Sciences (108 papers). The exported data were processed using the VosViewer software to carry out the bibliometric analysis and to develop the network visualization. VOSviewer is a software tool that allows to create maps based on network data, through which you can visualize, explore, extrapolate and create networks of scientific publications and journals, researchers from different research centres, funders, filtered by keywords. Authors, co-authors, co-occurrences, citations, bibliographic coupling or co-citation links can be used to link articles in the networks created. The software (van Eck & Waltman, 2010) is useful for creating networks, collecting data from multiple scientific databases and reference management files.

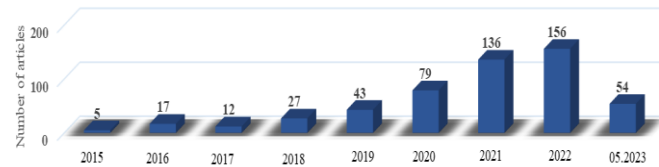


Figure 1. Annual trends in selected publications in the period 2015 - 2023 (Scopus database).

The unit of analysis was "authors" and the type of analysis was "co-authorship", using the counting method: "Full count". Limiting the number of documents per author to 2, resulted in 2,619 authors, and according to the criteria applied, only 267 authors met this threshold.

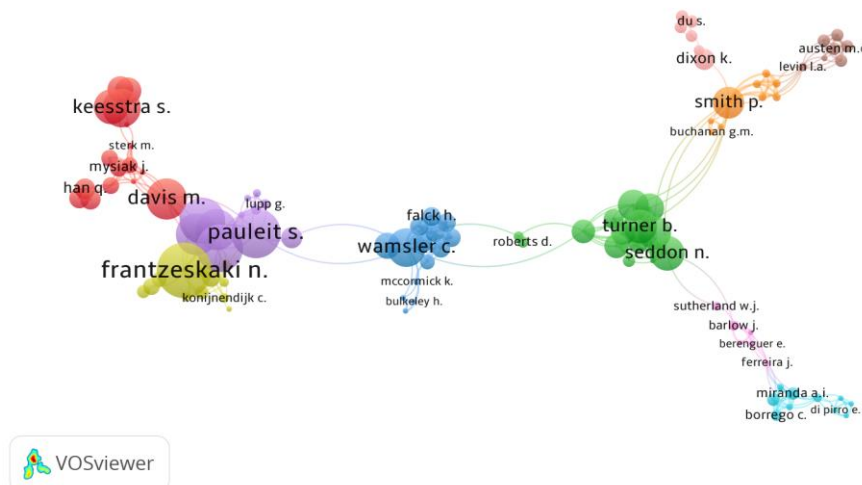


Figure 2. The network visualization - considering a minimum of 5 citations per article, the results of the network visualization show 105 items, 10 clusters and 312 links, with a total link strength of 462.

Of the 529 articles selected (43 articles, 78 reviews and 21 conference papers), 79 articles belong to a group of 11 researchers, as follows Franzeskaki N. And Wamsler, C.– 9, Vojinovic, Z. – 8, Haase, D., Seddon, N. And Smith, P. - 7, Laforteza, R., Pauleit, S. and Turner, B. – 6, Chausson, A. And McPhearson, T. – 5, followed by 11 authors with 4 articles and 43 authors with 3 articles.

Many authors come from 7 European countries, including the UK – 159, Germany – 100, Italy – 97, Netherlands – 80, France – 55, Sweden – 54 and Spain – 53 which have as sponsors the Horizon 2020 Framework Programme and the European Commission (156 papers) - as well as the Fundação para a Ciência e a Tecnologia (20 papers), European Regional Development Fund Natural Environment Research Council and Svenska

Forskningsrådet Formas (with 18 papers each), showing the importance of this area at European level.

The overlay visualization, with "Documents" as the weight and "Average Publication Year" as the score, shows that the areas studied - "Nature-Based Solution" and "Climate Change" - have received particular interest from researchers and practitioners in 2019, and that the level of interest has increased in the following years, as can be seen in Figure 3.

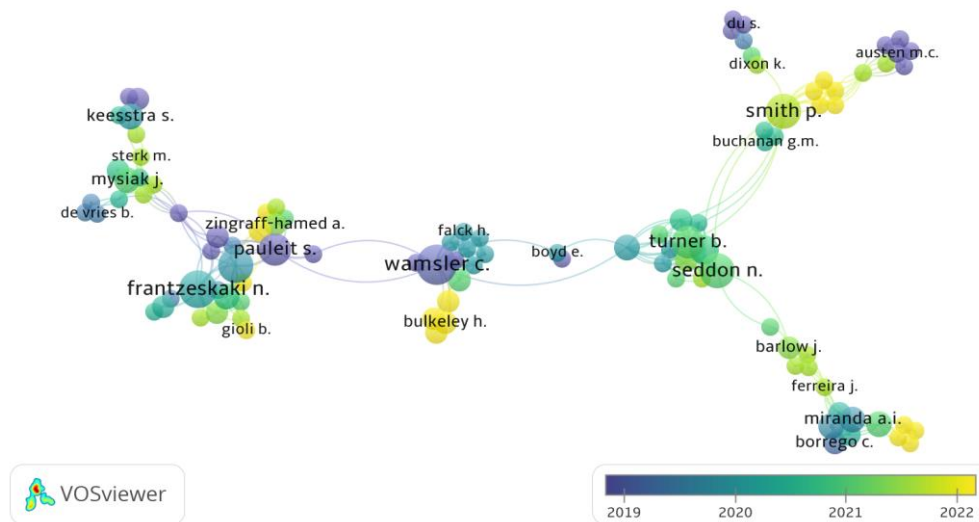


Figure 3. The Overlay visualization – publication selected – years 2019-2023.

The second stage of the research consisted of extracting relevant research articles, using extraction criteria based on the subfields of analysis that would answer the research question of our study: "What nature-based solutions could a local authority implement in the urban environment in the current climate change context, and what information does field research provide?"

Filters were therefore applied in the third phase, to refine the results. The keywords used were: "urban", "adaptation", "mitigate", "wellbeing", "greenspace", limiting the list of publications by applying the criterion of at least 10 citations per selected item. Thus, 65 articles dealing with climate change and NBS were retained for in-depth study from the 161 selected publications. The full texts of the 65 papers were analyzed and revised to apply new exclusions from the analysis in case the scientific publication did not answer the purpose and the research question. The entire flow of the review process and the application of the exclusion criteria based on the PRISMA statement (Moher et al., 2009) is shown in Figure 4.

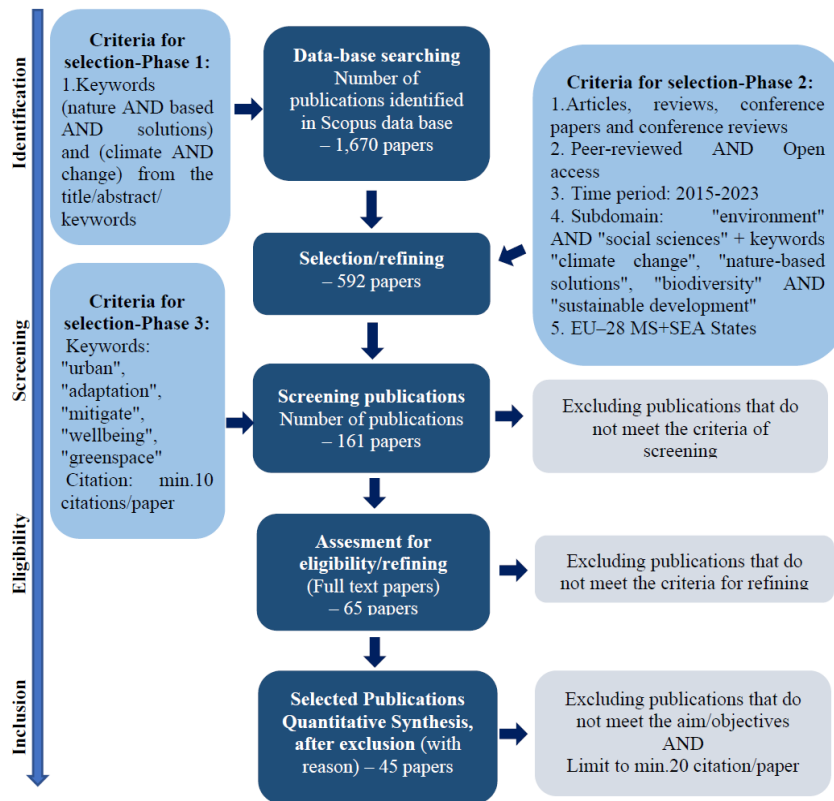


Figure 4. Flow of information through the different phases of a systematic review.

## RESULTS AND DISCUSSIONS

After selection, the number of articles selected for synthesis analysis was 38, limited by the criterion of at least 20 citations per article. Articles targeting a geographical area different from the geographical exclusion criterion were excluded.

An analysis of these articles clearly shows that the subject of NBS is multidisciplinary par excellence. It is identified with a wide range of closely related and interdependent fields, which illustrates the complexity of the issues related to NBS. To be able to classify the research analyzed, the generic key domains were chosen. These were used to structure relevant categories for the characterization of the domains that were the subject of the research.

As a result, out of the 38 articles analyzed, most of them deal with the creation of models, management methods or frameworks for approaching NBS through a transdisciplinary approach, or concept papers focusing on framing/defining NBS (7 articles), Drought, floods and water-related risk management (5 articles), those related to citizen participation, partnerships, empowerment through co-creation and co-implementation of NBS (4 articles), urban resilience and resilience planning (4 articles), GI and green-blue infrastructure (3 articles), strategic planning (3 articles), Ecosystem management services (2 articles), Decision-making and regulation (3 articles), Biodiversity and habitat restoration (2 articles), Living Labs, Health, Urban Food Supply, Social Cohesion, Coastal Protection with 1 article each (papers that have analyzed a certain type of NBS). All these types of NBS can be included in the local agenda of local authorities, after a thorough analysis of their effectiveness, to

maximize their benefits. The table (Table 1) shows the areas of interest and a brief analysis of the problems investigated, the recommendations formulated and the results.

*Table 1*

Analysis of the selected publication - Results of the quantitative synthesis according to the areas of focus and the characteristics of interest.

Area of focus/ SDG mapped	Characteristics of interest	Reference
Inter- and transdisciplinary cooperation/ SDG11 SDG 13 SDG 17	Exploration of NBS in urban areas that can contribute to mitigation of CC impacts and serve as proactive adaptation options for communities through inter- and transdisciplinary workshops with experts, researchers, community representatives, policies and other relevant stakeholders. Identifying needs to shape future scientific and policy agendas by building stronger evidence on NBS for CC adaptation and mitigation and raising awareness through increased implementation; Adapting to governance challenges, including through networking of leaders (NBS ambassadors and politicians); Social cohesion through inclusive and transdisciplinary participation of different actors.	(Kabisch et al., 2016)
Ecosystem management and services, Environmental governance, SDG15	Conceptual clarification of the concept of NBS and how it relates to sustainability to enable researchers, practitioners and decision-makers to better approach and understand NBS. Identify opportunities for transdisciplinary research and new long-term development alternatives through a systemic, integrated & stakeholder approach to sustainability.	(Nesshöver et al., 2017)
Co-creation, Urban resilience, Experimenting SDG9 SDG11 SDG13 SDG16	Analysis of 15 experimental situations involving NBS in 11 European cities. Demonstration of the balance between ecosystem and social benefits, and to a lesser extent climate benefits. It demonstrates the superiority of NBS over grey solutions. The comparative analysis of seven lessons learnt highlights the need for: aesthetic appeal for residents of NBS; creation of new green communities; need for trust in the experimental process; green goods community; implementation of NBS through learning from social innovation; need for collaborative governance; integration of NBS into multiple urban agendas; long-term replicability; Offers urban planners an open approach to collaborative governance of NBS for inclusion, liveability and resilience.	(Frantzeskaki, 2019)
Coastal protection, Experimental management, Restoration; SDG 11, SDG14	It addresses the global threat of coastal erosion and flooding, proposing seawall solutions to protect coastal human settlements and recommendations for restoring natural coastal habitats through NBS, by evaluating the effectiveness of solutions. To facilitate experimental testing of coastal protection systems, it proposes multidisciplinary research, including cost-benefit analyses.	(Morris, Konlechner, Ghisalberti, & Swearer, 2018)
Biodiversity, CC adaptation/mitigation, Policy SDG13, SDG14 SDG15, SDG17	It makes recommendations for researchers and practitioners to analyze NBS from a dual perspective: synergies and trade-offs, so that the actions implemented achieve their objectives. It recommends designing robust, time resilient NBS covering all types of ecosystems, involving indigenous peoples and local communities.	(Seddon et al., 2021)
Urban food supply, Systemic solution, SDG2, SDG8 SDG11, SDG12 SDG13, SDG17	Through a systemic literature analysis, the study shows that UPA contributes to ten societal challenges of urbanization and supports the consolidation of peri-urban agriculture as a NBS. To assess the implementation and effectiveness of UPA at the community level, the study develops an integrative evaluation framework.	(Artmann & Sartison, 2018)
Urban planning and resilience, ES, SDG8, SDG10 SDG11, SDG13	Proposes a framework for the urban planning of NBS. It contributes a set of questions and information to achieve the goal of urban resilience through NBS through an approach that includes spatial, functional and equity aspects. Highlights the anthropocentric nature of the urban planning process.	(Bush & Doyon, 2019)
Strategic planning, Barriers, Enablers, SDGs:11, 13, 15	The study defines the NBS as a theoretical concept through a systematic review of the specialized literature, which reveals the barriers and the supporting factors for the strategic planning framework of the NBS.	(S. E. Sarabi, Han, Romme, de Vries, & Wendling, 2019)
Stormwater, Urban	Review of NBS for urban water management in the literature and some	(Oral et al., 2020)

water, Wastewater treatment, CC, Resilience SDG6, SDG9 SDG11, SDG13	relevant projects, identification of three main applications: flood and drought management, water-food-energy nexus and water quality, highlighting the role of NBS in the rational use of water resources, biodiversity, urban microclimate and its multiple co-benefits, urging promotion of NBS that should be prioritized over conventional water infrastructure.	
Ecosystem services, CC, System analysis SDG13	Propose "a 'dynamic' assessment framework that explicitly accounts for the impact of CC on the effectiveness of the proposed NBS" based on an innovative approach that integrates system analysis and back-casting".	(Calliari, Staccione, & Mysiak, 2019)
Flood damage reduction, Drainage infrastructure, SDG9, SDG11 SDG13, SDG17	It shows that a combination of green-blue-grey measures in urban areas achieves results when more benefits are considered simultaneously and proposes a method of trade-off analysis when pursuing different benefits in stormwater infrastructure planning, including flood mitigation and enhancing co-benefits.	(Alves, Vojinovic, Kapelan, Sanchez, & Gersonius, 2020)
Adaptive management, SDGs:1, 9,11,13	Re-naturing the city, Reflections on urban landscapes, ecosystems services; "Brownfield greening as an adaptation strategy for vulnerable communities"	(Scott et al., 2016)
Decision making, Ecosystems, Sustainable development SDG11, SDG13, SDG16, SDG17	The report explores whether current forms and conditions of citizen engagement are (or are not) helping to create a platform to support nature-based solutions and ensure a transformative adaptation process. It recommends that to realize the potential of NBS and improve governance outcomes for CC, human and financial resources and the capacity to overcome constraints need to be supported at all levels and at all stages of implementation, but especially in planning, implementing and monitoring, and learning processes supported.	(Wamsler et al., 2020)
Droughts, Floods, Natural Disasters SDG13	Analyze a classification scheme, key features and elements for NBS and mitigating the negative impacts of Hydro-meteorological hazards (HMHs) in Europe, focusing on the main HMHs	(Debele et al., 2019)
Citizen participation, Co-creation, Co-production, Collaborative arrangements/governance SDG11, SDG13 SDG16, SDG17	Exploratory approach in 3 Swedish municipalities to map existing "adaptation interactions" and analyses how climate adaptation responsibilities are manifested and (re)negotiated, revealing that adaptation planning occurs without citizen collaboration, encouraging consideration of citizen collaboration for long-term support. It promotes 4 strategic aspects: "proactive engagement; equity and 'responsibilization'; nature-based approaches; and systematic adaptation mainstreaming"	(Brink & Wamsler, 2018)
Fuzzy cognitive map, Participatory modelling, Trade-off analysis SDG1, SDG6, SDG8 SDG15, SDG16	Case study: Copenhagen. A multi-sectoral analysis of the potential for NBS to deliver co-benefits while at the same time reducing the negative impacts of water-related hazards. It analyses the relationships between the co-benefits associated with the scenario of restoring the Ladegaardsaa urban river. It is hypothesized that once the social, economic and environmental factors and mutual influences are understood, the decision-making process can be improved, thus creating the framework for the achievement of the SDGs through NBS.	(Gómez Martín, Giordano, Pagano, van der Keur, & Máñez Costa, 2020)
ES, Greenspace, Nature-society relations, SDG8, SDG9,SDG11 SDG13, SDG17	Promote GI as a cost-effective means to contribute to mitigation and adaptation and to promote human well-being, including an exploratory perspective on the influence of ecosystem services in relation to the individual and society, as a means to promote biophilia in environmental management and climate action.	(Fink, 2016)
Barriers, Interpretive structural modeling, Strategic planning SDG11	It provides a taxonomy of the main barriers to the adoption and implementation of NBS and the identification of the interdependencies between them. Recommendations are made for cities wishing to implement NBS, and the results suggest that political, institutional and knowledge barriers are the most dominant barriers to NBS.	(S. Sarabi et al., 2020)
Adaptive management, Ecosystem management/service; Urban development/planning, SDG9,	The case study of 4 Swedish cities proposes to operationalize ecosystem-based adaptation by improving knowledge on how ecosystem-based approaches can be considered in local planning, and to identify key features of implemented and planned measures that support ecosystem-based adaptation. It proposes a more comprehensive approach to sustainable ecosystem-based adaptation planning and its	(Wamsler et al., 2016)

SDGs:11, 13,15,17	systematic inclusion.	
Collaboration, Knowledge, Partnerships, Planning SDG11, SDG13	Case study of three cities in Belgium, UK and Poland. Present a conceptual framework for NBS policy needs and how they relate to NBS delivery. By identifying the gaps, it proposes innovation-oriented actions and highlights the need for negotiation and collaboration skills to create the administrative linkages and multi-sectoral partnerships essential for planning and co-management of NBS. Proposes three solutions whose pillars are capacity building, infrastructure and spaces for collaborative learning and partnerships, and implementation of NBS through evidence-based policy.	(Frantzeskaki et al., 2020)
Age-sensitive landscape design, Evidence-based design, Healthy public space design, SDG11	Presents, through case studies, the concept of "mental health-sensitive open space design in the built environment" and the contribution of GI to the mental health and well-being of residents, particularly in relation to the growing prevalence of degenerative mental disorders in the urban environment. Through a critical analysis, it recommends design solutions capable of supporting healthy ageing and highlights the essential role of biodiversity in this process.	(Andreucci, Russo, & Olszewska-Guizzo, 2019)
Social cohesion, Well-being, Evaluation, Impact; SDG8, SDG11, SDG13	An assessment of the impact of NBS in Europe, identification of conceptual issues and empirical gaps and their policy implications. By formulating recommendations for practitioners and policy makers for the design and monitoring of NBS based on comparative evidence, in order to highlight their effectiveness in delivering ES to target social groups in the long term.	(Dumitru, Frantzeskaki, & Collier, 2020)
GI, Urban planning, Urban transformation SDG8, SDG9, SDG11, SDG13	Provides a diagnostic analysis of the position of NBS in strategic planning and programming documents, using the city of Poznań as a case study. It emphasizes the relationship between man and nature and the role that NBS can play by being integrated into local policies to address urban policy issues related to economic development, social cohesion, public health and well-being, and resilience to climate change. GI is recommended as a solution due to the quality of results, multifunctionality and the possibility of citizen support.	(Zwierzchowska, Fagiewicz, Ponizy, Lupa, & Mizgajski, 2019)
UHI, UGI, Regulation regulation; SDG9, SDG11, SDG13	To ensure healthy urban conditions for residents, it recommends the implementation of Urban Green Infrastructure (UGI) in cities. It presents a developed UGI microclimate regulation model for 601 urban areas. The model highlights the role of UGI in mitigating UHI at cities by simulating the temperature difference between a reference scenario vs. scenario without green spaces.	(Marando et al., 2022)
EBA, Empowerment SDG13	Presents a structured review of the literature on ecosystem-based adaptation, its role in providing social benefits to marginalized groups in the frame of the empowerment theory and highlights the variety of actions that can be integrated into practical adaptation strategies.	(Woroniecki, Wamsler, & Boyd, 2019)
UHI, Urban planning/rivers, Thermal comfort SDG6, SDG11, SDG13, SDG15	To explore people's satisfaction with the ecosystem services provided by urban green spaces in Cyprus, it presents the results of a survey of park visitors' perceptions and micrometeorological measurements.	(Giannakis, Bruggeman, Poulou, Zoumides, & Eliades, 2016)
Natural climate solutions, social appraisal SDG11, SDG13	It presents NBS and "natural climate solutions" as being attractive to the public and to political decision-makers and as being relevant as applications in climate policy. It also critically examines another facet, the risk of solutions being "risky, expensive, immature, and technocratic". Recommends analyzing climate solutions according to their "specific merits against a much broader set of frameworks".	(Osaka, Bellamy, & Castree, 2021)
Restoration, Environmental legislation, rewilding, wildlife management SDG13, SDG15	The article identifies relevant research areas for the provision of integrated solutions for the protection of biodiversity and current climate problems: understanding approaches, improving monitoring capacity and predictability of climate change on the effectiveness of NBS, new solutions adapted to spatial challenges and the need for a practical framework for assessing the risks of implementing NBS and managing these risks.	(Pettorelli et al., 2021)
Humans, Knowledge,	The article highlights the lack of knowledge in the design and planning	(Pineda-Pinto,



City Planning SDG10-11, SDG13	of non-anthropocentric NBS and carries out a systematic review of the literature from the perspective of ecological justice.	Frantzeskaki, & Nygaard, 2022)
Conceptualisation & operationalisation SDG8, SDG10-11 SDG13, SDG15	Presenting the EU roadmap to promote and introduce NBS as innovative solutions to transform the current society into a socially inclusive, economically vibrant and ecologically resilient one.	(Davies, Chen, Sanesi, & Laforteza, 2021)
Blue-green infrastructure, Sustainable water management, Urban circularity SDGs:6,7, 9, 11-13	Presents the results of meetings of more than 20 European experts to examine the effectiveness of NBS and to promote the adoption of NBS for circularity in urban water management, analyzing two challenges of urban circularity (UCC1 & UCC2) and synergies with other challenges, based on case studies, emphasizing the need to raise awareness of the opportunities offered by NBS to address urban circularity issues.	(Oral et al., 2021)
Living Labs SDG6, SDG11, SDG15-16	The article explores the concepts and approaches of Living Labs and suggests how they can facilitate and support deeper stakeholder engagement.	(Lupp, Zingraff-Hamed, Huang, Oen, & Pauleit, 2021)
Social-ecological-technological systems SDG8, SDG11, SDG13	It presents the results of decades of research, consisting of a Social-Ecological-Technical Systems framework for understanding four challenges related to NBS: "multi-functionality, systemic valuation, scale mismatch of ecosystem services, and inequity and injustice"	(McPhearson et al., 2022)
Hydro-meteorological risk reduction SDG7-8, SDG13	Discuss how NBS can be applied in the context of hydro-meteorological risk reduction in Mediterranean basins (touristic areas), using the Portofino Regional Natural Park as a case study.	(Turconi et al., 2020)
Adaptation and mitigation, CC SDG13, SDG14	It presents climate research results and a synthesis of 10 climate research topics where significant progress was made in 2020, including NBS.	(Martin et al., 2021)
Flood risk mitigation, SDGs:6, 11,13,15,16	It provides an overview of the NBS implemented in Germany. It suggests that the traditional governance model needs to be changed to focus on flood risk management and mitigation.	(Zingraff-Hamed et al., 2021)
Participatory modelling, System thinking, Water-related risks SDG2, SDG13, SDG15-17	It identifies the barriers to the implementation of NBS to support adaptation to CC and the reduction of water-related risks, particularly of a socio-institutional nature, and suggests the use of innovative tools for the planning, design, implementation and evaluation of NBS, as well as effective processes capable of supporting stakeholder participation. Causal Loop Diagrams were used to describe the process in terms of causal linkages and mutual influences, taking into consideration the views and ideas of stakeholders, enabling a comparative analysis of possible NBS based on the analysis of benefits and co-benefits.	(Coletta et al., 2021)
Stakeholder consultation SDGs:6, 9, 11,13	Presents the results of a collaborative, multi-stakeholder research exercise to identify the key knowledge needs (KN) that can be addressed to improve the adoption of NBS in the Mediterranean islands.	(Grace et al., 2021)

## CONCLUSIONS

The study of the selected articles provides several insights for decision-makers at the level of urban settlements, as well as for communities, organizations and even interested citizens, so that each of these target groups can find resources and approaches that will allow them to understand, initiate and implement projects involving NBS. The main conclusions of this literature review study are as follows:

- The challenges of the last decades, characterized by accelerated and unsustainable urbanization, pollution, degradation of the natural environment and loss of biodiversity, the effects of climate change and the impact on the health and well-being of the population, have led policy makers to reconsider the ecosystem services approach through NBS.

- In recent years, NBS has become increasingly popular in European cities to address urban challenges such as climate change, urban decay and ageing infrastructure. However, data and results on the effectiveness of NBS are still needed.

- NBS are a desirable qualitative approach to grey infrastructure, requiring a multidisciplinary approach from the initiation, design, implementation and monitoring of positive outcomes and impacts;

- At the level of urban settlements, the research findings confirm the need for in-depth knowledge of NBS field. The knowledge pool needs to be fed with information and knowledge on how to place NBS on the urban planning agenda.

- The effectiveness of NBS implemented at the local level must be based on co-design and co-participation in the implementation of projects that integrate NBS. This will ensure the highest level of acceptance at the community level.

- To achieve long-term benefits, NBS projects need to be implemented after a careful cost-benefit analysis of possible scenarios.

- Sufficient planning models, regulatory frameworks and modelling are proposed in the specialized literature so that NBS projects can be approached in a professional manner and with positive results.

- The short review only looked at the Scopus database. This is a limitation. Another limitation is the setting of the research at the level of EU-28 and European Economic Area MS. However, this paves the way for more in-depth research at the level of the NBS in the future, also from the perspective of other sub-fields such as: health, social equity and climate resilience.

#### **DECLARATION OF COMPETING INTEREST**

The author declares to have no known competing financial interests or personal relationships which might be perceived as influencing the work presented in this paper.

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