AÇÜ Uluslararası Sosyal Bilimler Dergisi
Yıl: 2022, Cilt: 8, Sayı:2, ss. 82-99

ACU International Journal of Social Sciences
Year:2022, Vol:8, Issue:2, pp. 82-99

Makale türü / Article type: Araştırma / Research

The Role of GIS-Based Thematic Urban Maps in Determining the Effectiveness of Nature-Based Solutions[1]

***

Doğa Temelli Çözümlerin Etkinliğinin Saptanmasında CBS Tabanlı Tematik Kentsel Haritaların Rolü

Dr. Tuğba Memişoğlu Baykal
Artvin Çoruh Üniversitesi, Faculty of Engineering, tugbamemisoglu@gmail.com
ORCID: 0000-0003-3548-6795

Dr. Tuğba Üstün Topal[*]
Tekirdağ Namık Kemal Üniversitesi, Faculty of Fine Arts, Design and Architecture, tustun@nku.edu.tr
ORCID: 0000-0002-9687-927X

Abstract

In the current century, the rapid increase in the world population and the fact that this population is living in cities to a large extent increases the speed and scale of urbanization more and more rapidly. This situation makes today's cities struggle with environmental, social, economic, and ecological challenges. In recent years, in order to cope with these difficulties, ecology-based planning and design approaches that take nature as an example have become important; At this point, new concepts and theories emerged. Nature-based solutions (NbS), a relatively new concept, are solution-oriented, measurable, and evidence-based comprehensive studies that deal with climate change and urbanization problems by integrating ecosystem-based approaches and relatively to increase urban sustainability. In this study, the development process of NbSs, the different platforms that deal with NbSs, what thematic map layers are in these platforms, and the importance of GIS-based thematic urban maps in determining the effectiveness of NbSs, since they are evidence-based and therefore measurable. Among the platforms examined, ThinkNature, UrbanGreenUp, NATURVATION, and Unalab platforms with applied project examples were discussed. The thematic map layers that can be used to question the activities of NBSs of each platform, respectively, were determined, and their relations with GIS were discussed. With the results obtained, it has been determined that the platform that offers the most visual and questionable thematic map layers is NATURVATION, UrbanGreenUp ranks second at this point, and ThinkNature and UnaLap platforms provide verbal suggestions to the user at the point of data layers. The platforms examined within the scope of the study and the criteria determined by other studies can be arranged in the GIS system, stored in databases, presented when necessary, and used at any planning point. In short, it was concluded that GIS-based thematic map layers can be an effective tool for preparing future scenarios of NbS.

Extended Abstract

Introduction: One of the most critical problems of recent years is rapid population growth. In particular, the search for new settlements by the increasing population and the social and economic reasons that people face have caused people to migrate from rural areas to urban areas, so the rate of urbanization has increased significantly. The uncontrolled increase in urbanization has led to the emergence of problems such as the occurrence of climate

[1] This study was accepted at Artvin Coruh University International Congress on Ecology, Economy and Regional Development (ECOSUS 2022) and its abstract was published in the abstract book.

[2] Corresponding author.

Makale gönderim tarihi / Received: 31.10.2022, Kabul tarihi / Accepted: 21.12.2022
DOI: https://doi.org/10.22466/acusbd.1196850

changes, a decrease in biodiversity, and environmental deformities. This situation has caused people who are in search of welfare to face more difficult situations. Therefore, solutions have been sought in cities, and it has been understood that it is necessary to adopt ecology-based planning and design approaches that take nature as an example. Naturally Based Approaches (NbS) have emerged as an important concept at the forefront of these approaches.

Method: Naturally Based Approaches (NbS) were introduced by the IUCN at the beginning of the 21st century and ".. providing environmental, social and economic benefits …. Nature-inspired and supported solutions designed to address societal challenges". This concept briefly deals with the conservation of biodiversity and environmental management. The European Commission then addressed the concept by including economic and social aspects. It is defined as multifunctional, large-scale, innovative, solution-oriented, evidence-based, comprehensive interventions that simultaneously address social, economic, and environmental sustainability issues and thus increase urban sustainability. NbS's have been studied and applied through many different research and innovation projects. These projects are ThinkNature, EKLIPSE, UrbanGreenUp, NATURVATION, Nature4Cities etc. There are also tools and databases with which the EU conducts research and innovation activities and partnerships for the promotion of NbS (Biodiversa, CLEVER Cities, Connecting Nature, EdiCitNET, Eklipse, GRaBS, GREEN SURGE, Grow Green, Inspiration, Nature4Cities, Naturvation, NAIAD, OpeNESS, OPERAs, OPERANDUM, PHUSICOS, proGIreg, RECONNECT, TURAS, Unalab, URBAN GreenUp, URBINAT, ReNAture). In addition, dialogue platforms that support innovation can be listed as ThinkNature, Oppla, EU Smart Cities Information System (SCIS), EU Climate Adaptation Platform CLIMATE-ADAPT, SUSTAINABLE CITIES PLATFORM (Somarakis et al., 2019). All these platforms include studies that will increase efficiency in the implementation and monitoring of NbSs. In this study, the development process of NbSs, the different platforms that deal with NbSs, what thematic map layers are in these platforms, and the importance of GIS-based thematic urban maps in determining the effectiveness of NbSs, since they are evidence-based and therefore measurable. Among the platforms examined, ThinkNature, UrbanGreenUp, NATURVATION, and Unalab platforms with applied project examples were discussed. The thematic map layers that can be used to question the activities of NbSs of each platform, respectively, were determined, and their relations with GIS were discussed.

Findings: The data layers considered in the efficiency query of NbSs were examined in tabular form by examining the four different platforms selected in the study. When viewed individually, it has been determined that NATURVATION is the platform that offers the most data layers, both visual and queryable. NATURVATION has six cities in common. These are: Barcelona, Utrecht, Leipzig, Malmö, Győr and Newcastle. These cities aim to organize urban-regional innovation partnerships with strategic urban management, business, and non-governmental organizations. Urban Nature Atlas, developed as part of the NATURVATION project, is the most comprehensive nature-based solution database ever created for cities. The NATURVATION platform also includes assessment maps (European Assessment Maps) of the European cities it deals with (Figure 2). These maps show the potential of nature-based solutions to address societal problems such as climate change, public health issues, and biodiversity loss in more than 700 European cities. UrbanGreenUp ranks second at this point. The three leading cities, Valladolid (Spain), Liverpool (England), and Izmir (Türkiye), demonstrate the effectiveness of the URBANGreenUP methodology. NbSs cover various aspects of urban life and complementary but interconnected infrastructures. These are grouped into four main categories. These; include renaturalization, urbanization, water interventions, singular green infrastructures, and non-technical interventions. ThinkNature and Unalap platforms have verbal suggestions about data layers. ThinkNature is run by a consortium of 17 partners from 8 countries across Europe and managed by the Technical University of Crete. There is a nature-based solutions handbook on this platform, and this book contains information on what factor layers should be in order to carry out NbSs effectively. UNaLab partner cities aim to address climate and water-related urban challenges with an innovative and people-focused approach. The three leading cities, Eindhoven, Tampere, and Genova, have the Urban Living Lab (ULL) that tests, demonstrates, and evaluates several different NbSs aimed at climate change mitigation and adaptation along with the sustainable management of water resources. Following these three cities, the project developed for Istanbul Başakşehir district in our country also contributes to this project. It aims to apply NbS against numerous challenges, such as heat stress, pollution, loss of biodiversity, and water scarcity due to climate change and rapid population growth. The examined

platforms are summarized in the organized table, and the thematic map layers, essential in questioning the activities of NbSs, are briefly mentioned.

Conclusion and recommendations: In line with the platforms and other studies examined within the scope of the study, it was concluded that GIS-based thematic map layers could be an effective tool in preparing future scenarios. Thanks to the GIS-based database being created with thematic map layers, it is thought that decision-making processes will be faster and will play an active role in the supervision of NbSs. Analyzes to be made with selected map layers can play an active role in measuring and controlling NbSs. Thanks to the thematic map layers, it will make essential contributions to questioning the effectiveness of NbSs and using them effectively. It is thought that it will help NbS-based studies the point of raising awareness, thanks to the fact that the map layers are in a questionable and visually inspectable position. In addition, with the presentation of socially thematic map layers, the public's attention can be drawn to NbSs, and participation in planning/design issues can be ensured. Thematic maps will make important contributions to the effective use of NbSs as well as questioning the effectiveness of NbSs.

Keywords: Nature-based solutions, NbS, Thematic map, GIS, Urban sustainability.

Özet

İçinde bulunduğumuz yüzyılda, dünya nüfusunun büyük bir hızla artması ve bu nüfusun da büyük ölçüde kentlerde yaşamaya başlaması, kentleşmenin hızını ve ölçeğini giderek daha hızlı bir şekilde arttırmaktadır. Bu durum günümüz kentlerini çevresel, sosyal, ekonomik, ekolojik gibi zorluklarla hiç olmadığı kadar mücadele içine sokmaktadır. Son yıllarda bu zorluklarla başa çıkabilmek adına, doğayı örnek alan ve ekoloji temelli planlama ve tasarım anlayışı yaklaşımları önemli hale gelmiştir. Doğa temelli çözümler (NbS) bu yaklaşımların başında gelen, iklim değişikliği ile mücadeleyi ve kentleşme sorunlarını ekosistem temelli yaklaşımları bütünleştirerek ele alan ve nispeten yeni, kentsel sürdürülebilirliği arttırmaya yönelik çözüm odaklı, ölçülebilir, kanıta dayalı geniş kapsamlı çalışmalardır. Bu çalışmada, NbS'lerin gelişim süreci, NbS'leri ele alan farklı platformlar ve bu platformlarda ele alınan tematik harita katmanların neler olduğu ve CBS tabanlı tematik kentsel haritaların kanıta dayalı ve dolayısıyla ölçülebilir olmaları nedeniyle, NbS'lerin etkinliğinin belirlenmesindeki önemi üzerine yoğunlaşılmıştır. İncelenen platformlar içerisinden, uygulamalı proje örneklerinin yer aldığı ThinkNature, UrbanGreenUp, NATURVATION ve Unalab platformları ele alınmıştır. Sırasıyla her bir platformun NbS'lerin faaliyetlerini sorgulamak için kullanılabilecek tematik harita katmanlarının belirlenerek CBS ile ilişkileri ele alınmıştır. Elde edilen sonuçlarla, hem görsel hem de sorgulanabilir en fazla tematik harita katmanı sunan platformun NATURVATION olduğu, UrbanGreenUp'ın bu noktada ikinci sırada yer aldığı, ThinkNature ve UnaLap platformlarının veri katmanları hakkında sözlü önerileriyle kullanıcıya sunum sağladığı tespit edilmiştir. Çalışma kapsamında incelenen platformlar ve diğer çalışmalar doğrultusunda belirlenen kriterlerin CBS sisteminde düzenlenerek veritabanlarında saklanılmasına gerektiğinde sunumuna ve herhangi bir planlama noktasında kullanılmasına dair öneriler getirilerek farklı ölçeklerdeki NbS çalışmalarının etkinliğindeki önemine vurgu yapılmıştır. Kısacası CBS tabanlı tematik harita katmanlarının NbB'lerin gelecek senaryolarının hazırlanmasında etkili bir araç olabileceği sonucuna varılmıştır.

Anahtar Kelimeler: Doğa temelli çözümler, NbS, Tematik harita, CBS, Kentsel sürdürülebilirlik.
JEL Sınıflandırması: S54, Q56, Q57

INTRODUCTION

Human beings, which rapidly change and transform the world they live in for their activities, are faced with global problems caused by themselves today. Environmental problems such as irreversible destruction of natural resources as a result of rapid population growth and increasing consumer demands, melting of glaciers as a result of climate change, desertification, drought, famine, flood, air pollution, noise, dust and heat, disposal of solid wastes have become global problems today (Korkut, Gültürk & Topal, 2016; Rahımbaylı & Polat, 2021; Uttara, Bhuvandas & Aggarwal, 2012). The emergence of the need for new settlements for the increasing population, on the other hand, the fact that the existing populations started to live in urban areas rather than rural areas due to social and economic reasons,

increased the speed and scale of urbanization significantly (Chaolin, 2020; Ejaro & Abubakar, 2013; Topal, 2021).

Such rapid and uncontrolled urbanization has made problems such as the increase in the urban heat island effect of climate change, the decrease in thermal comfort areas, and the decrease in biodiversity more effective in cities. This significantly affects the welfare and quality of life of the society, most of which lives in cities. Thus, today's cities face many social, environmental, and economic challenges (Bush & Doyon, 2019; Çobanyılmaz & Yüksel, 2013; Korkut, Kiper & Topal, 2017; Majidi, Vojinovic, Alves, Weesakul, Sanchez, Boogaard & Kluck 2019). Urban resilience is the capacity to meet the first damages that occur due to problems in the city and urban systems, to reduce the effects of problems, to maintain the desired functions in the face of a problem, and to adapt to change (Meerow, Newell & Stults, 2016; Ribeiro & Gonçalves, 2019). Many harmful situations listed above, such as urbanization, decrease in biodiversity, loss of ecosystem services, social and economic inequality, and global climate change, put cities in a struggle with resilience problems. As these problems are being experienced more and more effectively in today's cities, it is expected that the resilience problem that cities face will increase (World Bank, 2021).

As a matter of fact, as a result of urbanization and climate change, solutions have been sought in cities. With the emergence of the concept of a sustainable city, it has been understood that it is necessary to adopt ecology-based planning and design approaches that take nature as an example. The emergence of new concepts and theories in this context followed this situation.

One of the concepts that emerged in the above-mentioned issue is Nature-Based Solutions (NbS). NbS is defined as multifunctional, large-scale, innovative, solution-oriented, evidence-based, comprehensive interventions that simultaneously address social, economic and environmental sustainability issues and thus increase urban sustainability (Cohen-Shacham, Andrade, Dalton, Dudley, Jones, Kumar, Maginnis, Maynard, Nelson, Renaud, Welling & Walters, 2019; Dorst, van der Jagt, Raven & Runhaar, 2019; Krauze & Wagner, 2019; Tan, Gaw, Masoudi & Richards, 2021; Albert, Brillinger, Guerrero, Gottwald, Henze, Schmidt & Schröter, 2021; Kabisch, Frantzeskaki & Hansen, 2022; Gottwald, Brenner, Janssen & Albert, 2021; Frantzeskaki, McPhearson, Collier, Kendal, Bulkeley, Dumitru, ... & Pintér, 2019). At the same time, NBSs are integrative solutions in the context of urban resilience (World Bank, 2021). In this direction, studies on NbS, which is a relatively new concept, have been increasing in recent years (Raymond, Frantzeskaki, Kabisch, Berry, Breil, Nita, Geneletti & Calfapietra, 2017; Seddon, Smith, Smith, Key, Chausson, Girardin, House, Srivastava & Turner, 2021; Welden, Chausson & Melanidis, 2021). However, while there is still limited research on how NBS can advance urban policy and planning (Frantzeskaki, 2019), international policies towards NbS, especially in the areas of climate and biodiversity, are in great development (Welden et al., 2021). On the other hand, the Sustainable Development Goals (SDGs) put forward by the United Nations in 2015 are also accepted as a universal call to action (WEB 1, 2022). Due to their scope, NbSs also support the realization of these goals, which reveals the importance of the concept.

Geographical Information System (GIS) is defined as “an information system that collects, stores, processing and presents graphical and non-graphical information obtained by location-based observations to the user in integrity.” (Yomralioglu, 2000). GIS is used in many applications for storing, processing, analyzing, and presenting data; it provides convenience to the user, especially in analyzing data by organizing, planning, and design stages (Yomralıoğlu, 2000; Memisoglu, 2020; Memisoglu Baykal & Colak, 2021). It provides advantages in storing and presenting data by using GIS effectively to determine the effectiveness of NbSs and carrying out fast and effective studies in future planning and designs. In particular, the collection and presentation of the layers of thematic maps in GIS-based systems are

essential, making the design and planning stages faster and easier thanks to the GIS database. In addition, it provides access to different audiences with the presentation of data.

In this study, the importance of Geographic Information Systems (GIS)-based thematic urban maps in determining the effectiveness of NbSs, based on their evidence-based and thus measurable nature, was examined. In this context, the projects on the platforms created for the promotion and awareness of NbSs were examined, and an answer was sought to the question "*Which data layers and data should be provided in questioning the effectiveness of NbSs, which thematic map layers are needed?"* Based on this information, criteria that can be used to question the effectiveness of NbS studies at different scales were determined and evaluated, and suggestions were presented.

1. DEVELOPMENT OF THE NbS CONCEPT

The term nature-based solutions (NbS) was coined in the early 21st century, mostly by IUCN about biodiversity conservation and environmental management. Later, the European Commission addressed the concept by including economic and social aspects (Dorst et al., 2019; Eggermont, Balian, Azevedo, Beumer, Brodin, Claudet, Fady, Grube, Keune, Lamarque, Reuter, Smith, Van Ham, Weisser & Le Roux, 2015; Somarakis, Stagakis & Chrysoulakis, 2019).

In 2008, the concept of NbS was discussed in the World Bank Report, which was also based on climate change and the conservation of biological diversity (World Bank, 2008). In 2009, IUCN started to be seen as an innovative tool concerning NbS in the United Nations Framework Convention on Climate Change Position Paper and studies continued in this context. The European Commission has made progress on NbS under the Horizon 2020 Framework Program to position Europe as a world leader in this field (Eggermont et al., 2015) (Figure 1).

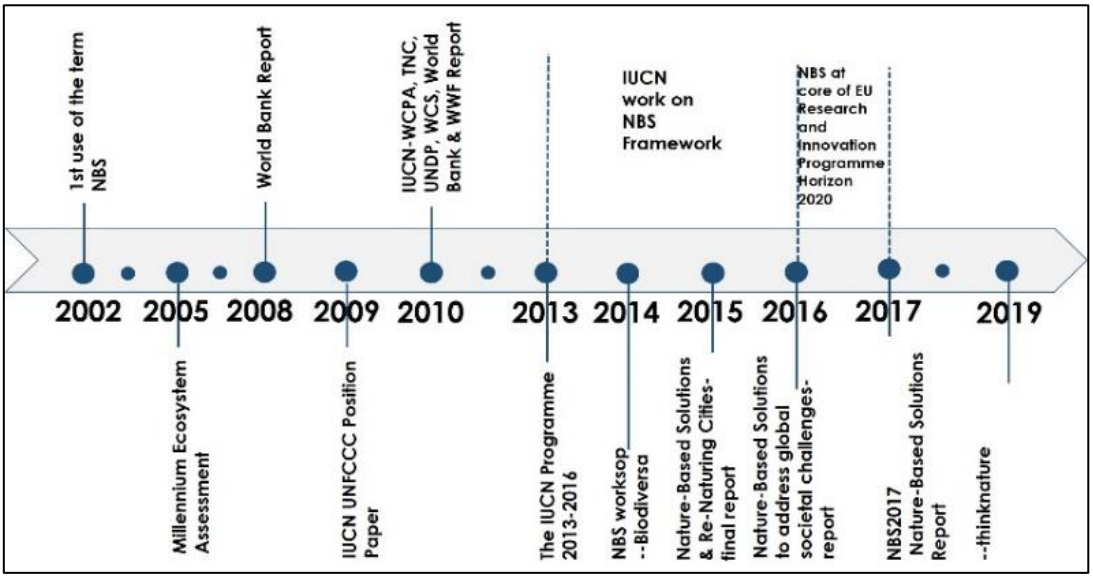

Figure 1. Timeline for NbS (Eggermont et al., 2015).

NbS and NbS approaches, which is a very comprehensive term covers different definitions and related terminologies such as ecological restoration, ecological engineering, forest landscape restoration, natural and green infrastructure, ecosystem-based management, ecosystem-based adaptation, ecosystem-based mitigation, ecosystem-based disaster risk reduction, climate adaptation services (Cohen-Shacham, Walters, Janzen & Maginnis, 2016).

The IUCN European Commission defines NbS as "… providing environmental, social and economic benefits … nature-inspired and supported solutions designed to address societal challenges (Cohen-Shacham et al., 2019). The NbS for sustainable conceptual explanation is shown in Figure 2.

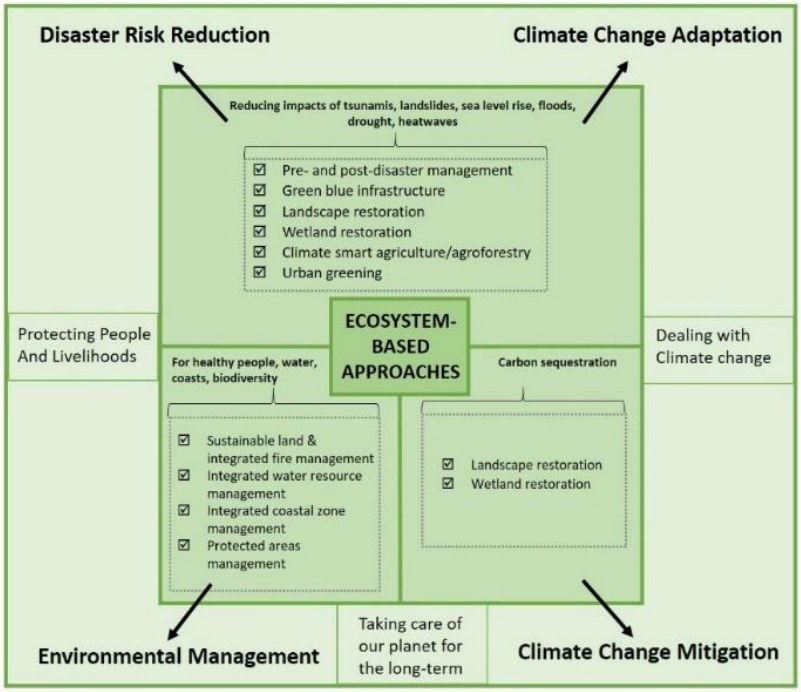

Figure 2. NbS for sustainable development concept (Modified from UNDRR, 2021)

The IUCN has developed eight principles that will be essential in achieving a full understanding of NbS. If we summarize these principles, NbS (Cohen-Shacham et al., 2016):

(1) Adopts nature conservation principles,

(2) Can be applied alone or integrated with other solutions to societal challenges,

(3) It is determined by the natural and cultural conditions specific to the area,

(4) Produces social benefits in a fair and equitable manner,

(5) Protects biological and cultural diversity,

(6) It is applied on a landscape scale,

(7) It considers future options for the production of all ecosystem services with the immediate production of economic benefits for development, and we can say

(8) it is an integral part of the policy, measures or actions that are produced to overcome a particular challenge.

2. SOME PLATFORMS TO CONSIDER NbS TOOLS

In order to facilitate the implementation and monitoring of NbSs in Europe, priority has been given to the development of online catalogs and licensed tools (manuals, models) and databases over the last five years (Mino, Pueyo-Ros, Škerjanec, Castellar, Viljoen, Istenič & Comas, 2021; Wang, Huang, Xu & Wang, 2021).

As NbS is also on the agenda of the European Union, research and innovation projects for more resilient and sustainable urban areas have been financed. Some of these projects have been implemented in the past years. These; Like ThinkNature, EKLIPSE, UrbanGreenUp, NATURVATION, Nature4Cities (Mino et al., 2021). Political and financial support was also called for at The Climate Action Summit 2019, especially for new activities aimed at popularizing NbSs (Wang et al., 2021). In this context, Biodiversa, CLEVER Cities, Connecting Nature, EdiCitNET, Eklipse, GRaBS, GREEN SURGE, Grow Green, Inspiration, Nature4Cities, Naturvation, NAIAD, OpeNESS are the tools and databases with which the EU conducts research and innovation activities and partnerships for the promotion of NbS, OPERAs, OPERANDUM, PHUSICOS, proGIreg, RECONNECT, TURAS, Unalab, URBAN GreenUp, URBINAT, Renature. In addition, dialogue platforms that support innovation can be listed as ThinkNature, Oppla, EU Smart Cities Information System (SCIS), EU Climate Adaptation Platform CLIMATE-ADAPT, and SUSTAINABLE CITIES PLATFORM (Somarakis et al., 2019). All these platforms include studies that will increase efficiency in implementing and monitoring NbSs.

ThinkNature, UrbanGreenUp, NATURVATION, and Unalab platforms, which include implemented project examples, are discussed in this study. The projects on these platforms were examined and evaluated. Moreover, the data that could be used to query the activities of NbSs and the GIS-based map layers that could be created with these data were determined. The scopes of the platforms covered in the study are briefly explained below.

2.1. ThinkNature

The ThinkNature project is part of Horizon 2020, the EU Research and Innovation Framework Programme. The project aims to develop a platform that supports understanding and promoting NbSs. The execution of this project belongs to a consortium of 17 partners from 8 countries. Moreover, it is managed by the Technical University of Crete (WEB 2, 2022). This platform adopts: to drive dialogue through forums and discussions; identify, communicate and promote successful NbS; identify regulatory, economic, and technical barriers; promote cooperation at local, regional, national, and EU levels; Develop synergies with other projects in NbS (WEB 2, 2022).

When this platform is considered in terms of map layers, we come across the nature-based solutions handbook published by the platform. This handbook explains what factor layers should be to effectively conduct NbSs at different scales (Somarakis et al., 2019). Without visual and questionable thematic map layers, this platform offers only a verbal approach to the layers that can be used in implementing NbSs, based on the handbook mentioned above.

2.2. NATURVATION

NATURVATION is a project planned by the European Commission over four years. This project embraces the fields of urban development, geography, innovation studies, and economics, covering 14 institutions across Europe. While improving understanding of what nature-based solutions can achieve in cities is its primary objective, it also aims to examine how innovation can be fostered in this field and to work with communities to realize the potential of nature-based solutions to respond to urban sustainability challenges (WEB 3, 2022). Barcelona, Utrecht, Leipzig, Malmö, Győr, and Newcastle are six cities that are partners of NATURVATION; they aim to organize urban-regional innovation partnerships (URIPs) with strategic urban management, business, and non-governmental organizations. URIPs aims to contribute to the project by providing information on how nature-based solutions are used in different urban conditions. In addition to six cities as URIP, the NATURVATION project conducts research and study tours in six cities in Europe and six cities around the world. Urban Nature Atlas has been developed within the scope of the NATURVATION project and is the most comprehensive nature-

based solution database ever created for cities. The Urban Nature Atlas resulted from a systematic survey of nature-based solution interventions in 100 European cities. It provided the basis for analyzing European socio-economic and innovation patterns associated with urban nature-based solutions (WEB 3, 2022). The NATURVATION platform includes European Assessment Maps for the European cities it deals with (Figure 3). These maps show the potential of nature-based solutions to address societal problems such as public health issues, climate change, and biodiversity loss in more than 700 European cities. The future potentials of nature-based solutions in cities are explored alongside a scenario-based modeling approach to quantify and map the multiple benefits of existing urban nature-based solutions. With these scenarios, other urban developments are foreseen in the future. The NbS potential in the city can be easily seen through these maps on the platform (WEB 4, 2022).

The platform also publishes the Urban Nature Cityscale Assessment Map. These city-scale maps show the potential of nature-based solutions for adaptation to climate change, including three selected cities Malmö, Barcelona and, Utrecht. Here, using open-source GIS-based modeling, a set of tools is used to measure the benefits of urban nature-based solutions under six different scenarios and indicators (WEB 4, 2022). The scenario and map layers are used in Figure 4; Figure 5 shows examples of maps created with these layers.

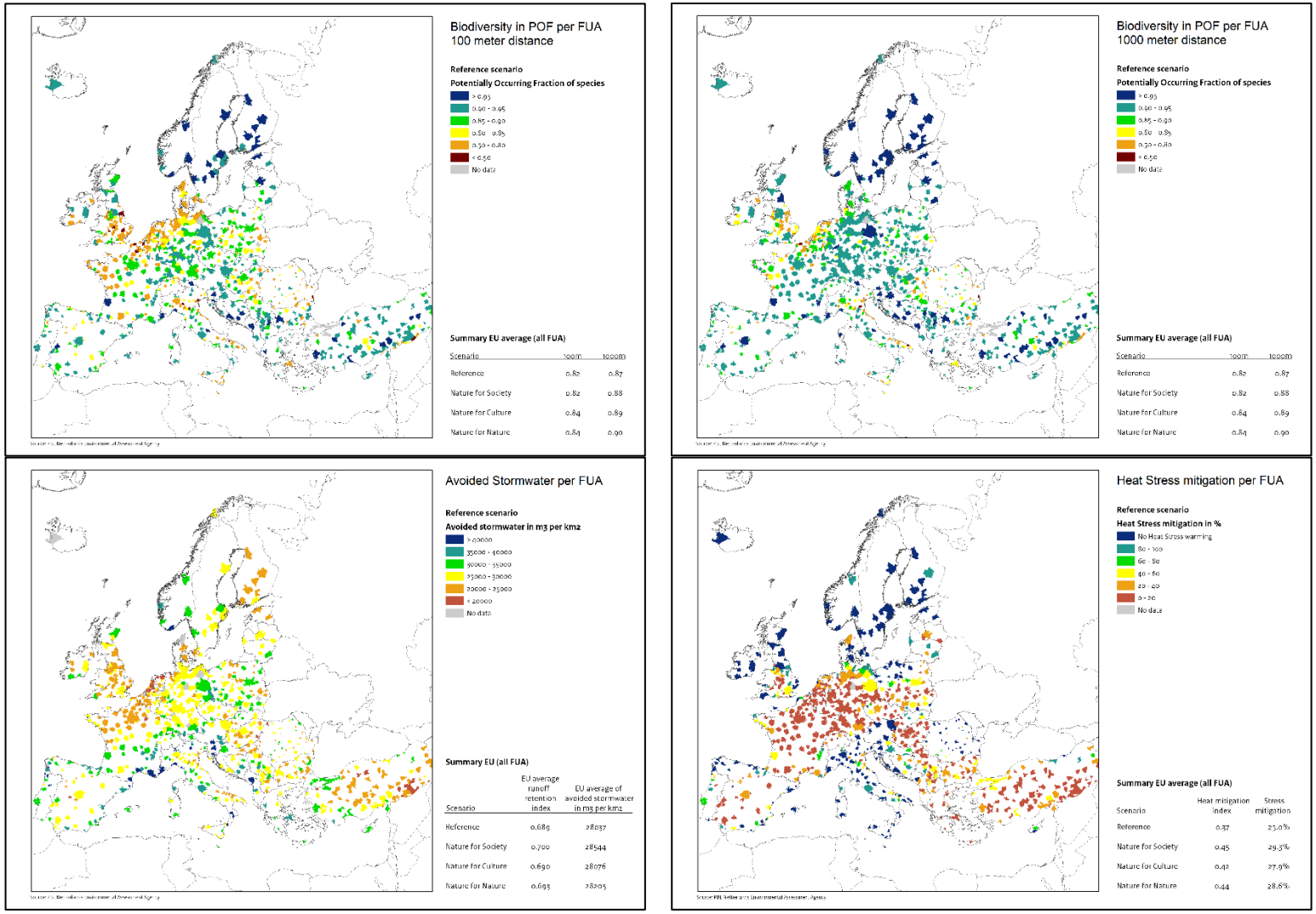

Figure 3. Layers and sample representation of assessment maps of European cities on the NATURVATION platform (WEB 4, 2022)

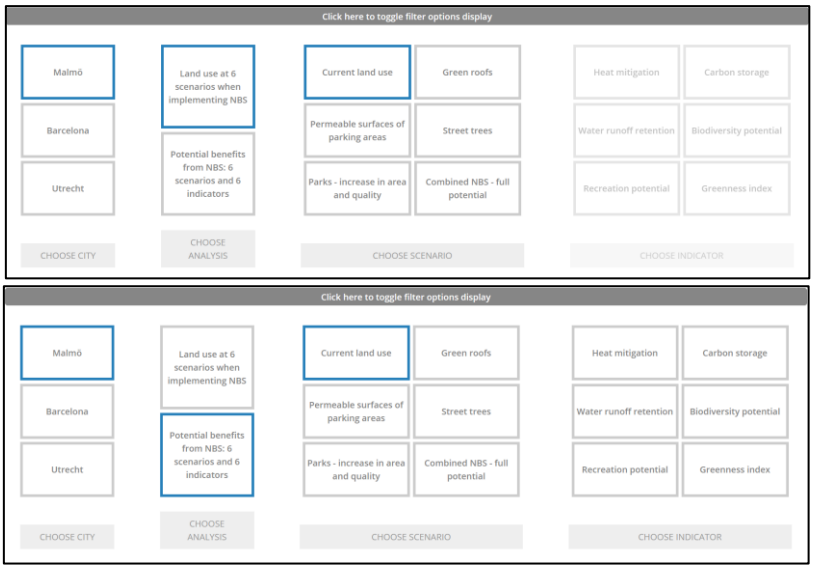

Figure 4. Examples of scenarios and map layers used in city-scale assessments on the NATURVATION platform (WEB 5, 2022)

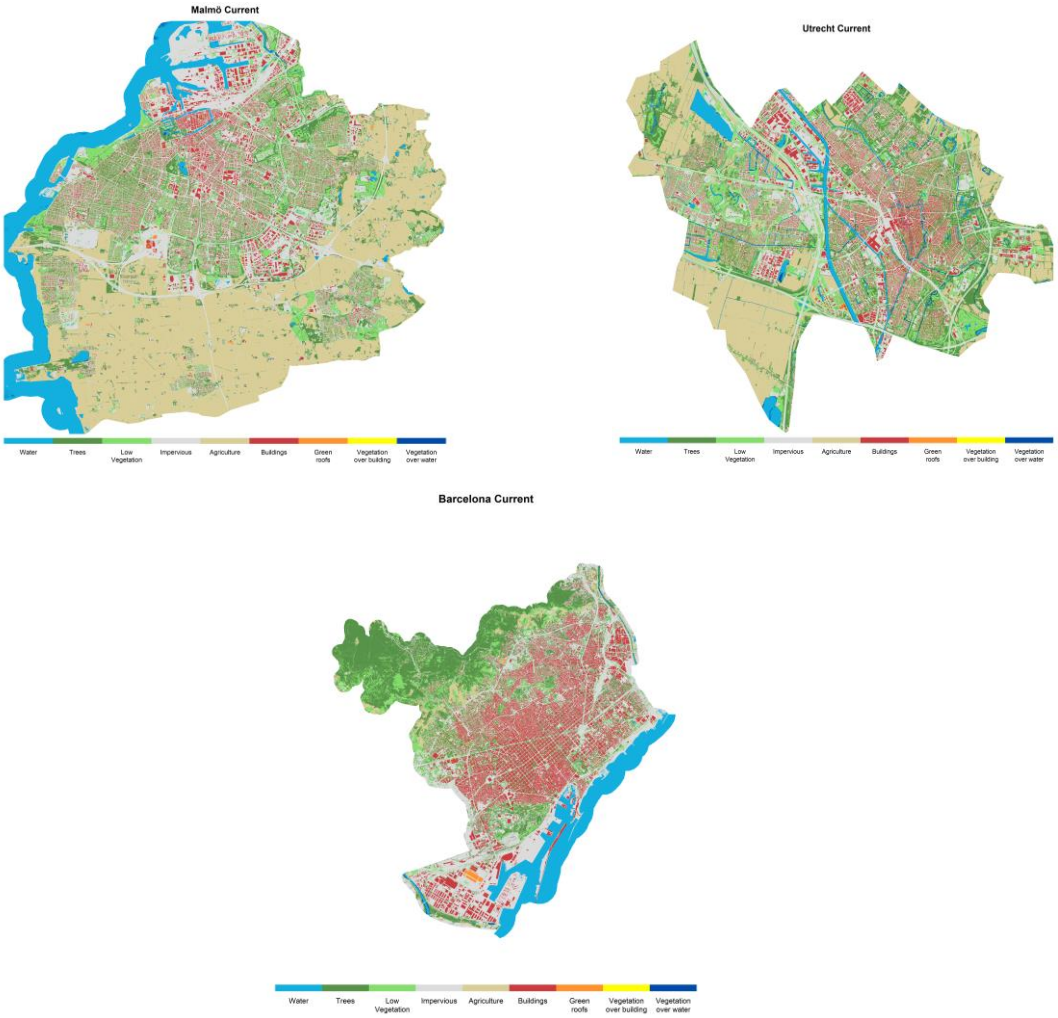

Figure 5. Map samples created for city-scale assessments on the NATURVATION platform (WEB 5, 2022)

2.3. UrbanGreenUp

URBAN GreenUP is a project within the scope of the European Union's Horizon 2020 program. It aims to develop, implement and iterate renewed city plans in various European and non-European partner cities. The reason for this is to reduce the effects of climate change, improve air quality and water management and increase the sustainability of cities with innovative NbSs. The cities of Mantova (Italy), Ludwigsburg (Germany), Medellin (Colombia), Chengdu (China), and Binh Dinh-Quy Nhon (Vietnam) will create their own renewed urban plans to replicate the URBAN GreenUP strategy and its green economy approach. (WEB 6, 2022). The NbSs to be implemented in the projects cover various aspects of urban life and infrastructures that complement each other but are interconnected. These are grouped into urbanization, renaturalization, singular green infrastructures, water interventions, and non-technical interventions. When this platform is considered in map layers, the maps it offers, mainly the three leading provinces, are seen (Figure 6) (Somarakis et al., 2019).

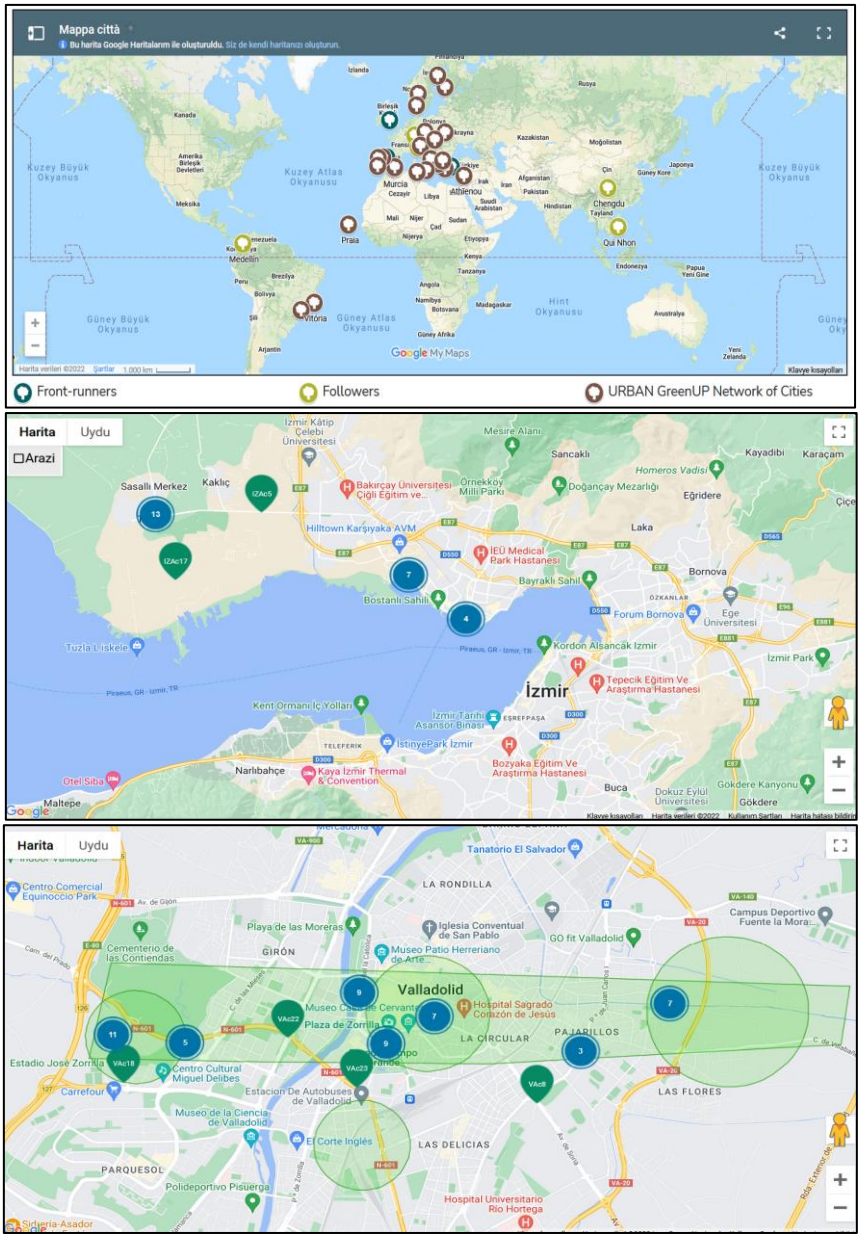

Figure 6. Examples of provincial maps presented on the UrbanGreenUp platform (WEB 7, 2022)

2.4. Unalab

The EU funded the UNaLab project. It aims to develop more innovative, inclusive, resilient, and increasingly sustainable societies through innovative NbSs. The UNaLab Consortium consists of 28 partners from 10 cities in Europe and beyond, including municipalities, research, business, and industry. UNaLab partner cities aim to tackle climate and water-related urban challenges through an innovative and people-oriented approach. Eindhoven, Tampere, and Genova are the main cities of Unalab. These cities have Urban Living Lab (ULL), which tests, demonstrates, and evaluates several different NbS for climate change mitigation and adaptation as well as sustainable management of water resources. These solutions are jointly created for local stakeholders and the community (WEB 8, 2022).

Following these three cities, studies are also carried out within this platform in our country. The project developed for Istanbul Başakşehir district also contributes to this project. Başakşehir faces numerous challenges, such as heat stress, pollution, biodiversity loss, and water scarcity due to climate change and rapid population growth. To overcome these difficulties, Başakşehir aims to implement NbS. The city's 2050 vision is to be a residential area with trees, green riverbeds, and interconnected green and blue areas along its paths, where people can enjoy it, making walking and cycling an attractive option. For Başakşehir, the goal is to have zero wastewater by 2050, instead focusing on storing, recycling, and treating water so it can be used multiple times. The primary goal of Başakşehir is the implementation of public green spaces and similar NbSs to reduce energy consumption and CO_2 emissions in the city and the effects of climate change (WEB 9, 2022).

When this platform is considered in terms of map layers, although there are no evaluations on map layers in the projects, it is suggested which factors should be considered to effectively carry out the NbSs presented in line with the objectives of the projects. The data and map layers are pointed out.

3. THE NECESSITY OF GIS-BASED THEMATIC MAP LAYERS IN THE EFFECTIVE USE OF NbSS

Thanks to its advantages, such as storage, querying, analysis, and presentation, GIS is an effective tool used in many fields for years. As in all other fields, it is needed to be used effectively in the field of NbS, as it will enable the making of plans and arrangements. Thus, it will provide advantages in storing, processing, analysing and, presenting thematic map layers that can be used in planning NBSs. It will also provide convenience in terms of data access and use. Although many NbS platforms do not have a regular system, they organize the thematic map layers and present them on the web, providing easy access to the user. Thanks to the fact that the platforms examined offer thematic data layers through a system, users at different points can access the same data, so the design and planning stages can be faster and easier thanks to the GIS database. Therefore, GIS provides essential conveniences and enables a more effective study to be carried out.

With this study, which was designed based on all these advantages of GIS, the thematic data layers necessary for the effective use of NbS, how these layers are used, whether they are GIS-based, and the benefits it provides are examined before platforms that take NbS into account. In this context, first of all, the relevant platforms were examined, focused on the thematic map layers they offered, and suggestions were made in the study by examining the relations to be established with GIS.

4. THEMATIC MAP LAYERS USED IN DETERMINING THE EFFECTIVENESS OF NbS

Projects on ThinkNature, UrbanGreenUp, NATURVATION, and Unalab platforms examined within the scope of the study have shown that reporting is an essential tool for obtaining quantitative data and questioning the effectiveness of NbSs. For example, thematic maps such as biodiversity maps and land use status maps will be good guides for comparing values before and after regulation. From here, the

study also seeks to answer the *"Which data layers and data should be provided in questioning the effectiveness of NbSs? Which thematic map layers are needed?"* question becomes important. Map layers used to query NbS activity are online guides, platforms considered online tools, reports, and case studies analyzed, evaluated, and presented in Table 1. When the presented table is examined, it will ensure that the specified thematic map layers are collected and stored in a database in a GIS environment, so that they can be used effectively especially in future planning, thus giving users an idea of what data should be used at any point where NbS planning will be made.

When this table is examined, it has been determined that NATURVATION is the platform that offers the most data layers, both visual and queryable. UrbanGreenUp ranks second at this point. ThinkNature and UnaLap platforms have verbal suggestions about data layers. In the NATURVATION platform, layers and information were found within the scope of biodiversity and biodiversity potential, carbon storage, carbon storage potential, carbon reduction, heat reduction potential, heat stress reduction, keeping the water flow, water retention potential, rainwater regulation, surface permeability of open areas, land use status, urban agriculture, parks-area and quality improvement, recreational potential, street trees, green roofs/walls, green index, unified nbs - full potential, green area availability. In the UrbanGreenUp platform, layers and information were found within the scope of biodiversity and biodiversity potential, carbon reduction, keeping the water flow, water retention potential, rainwater regulation, rain garden, surface permeability of open areas, reducing air pollution, urban gardens/forests, green networks, greenways, green bridges, street trees, green roofs/walls, green urban equipment, bicycle and pedestrian routes, educational gardens and paths. It has been observed that the layers of biodiversity, keeping the water flow, rainwater regulation, rain garden, land use status, urban agriculture, parks-area and quality improvement, green networks, greenways, green bridges, street trees, green roofs/walls, educational gardens and paths, sudden natural disaster risks are verbally indicated on the ThinkNature platform. On the UnaLap platform, it is seen that the layers of biodiversity potential, heat stress reduction, keeping the water flow, rainwater regulation, rain garden, surface permeability of open areas, reducing air pollution, urban gardens/forests, street trees, green roofs/walls, bicycle and pedestrian routes are mentioned. It is important to collect and present the layers of thematic maps offered by these platforms, especially in GIS-based systems. Thus, by determining the effectiveness of NbSs, fast and effective studies and operations can be carried out in future planning and designs.

Table 1. Map layers that can be used to question the effectiveness of NbSs (created by the authors inspired by the data of references WEB 4, 2022; WEB 7, 2022; WEB 8, 2022; WEB 10, 2022; Majidi et al. 2019; Tan, et al., 2021; Hutchins, Fletcher, Hagen-Zanker, Jia, Jones, Li, …& Yu, 2021).

Main NbS subject		ng biodiversity and		Carbon cycle			Temperature control		Water and water cycle					Soil remediation		Air improv	Land use		Open-green areas								Pollination	Utilization and Accessibility				Hazards and	Noise control	Unifie
Map layers		Biodiversity (100m and 1000m)	Biodiversity potential	Carbon storage	Carbon storage potential	Carbon reduction	Heat reduction potential	Heat stress reduction	Keeping the water flow	Water retention potential	Water quality	Rainwater regulation	Rain garden	Soil erosion	Surface permeability of open areas	Reducing air pollution	Land use status	Urban agriculture	Parks-area and quality improvement	Recreational potential	Urban gardens/forests	Green networks, greenways, green bridges	Street trees	Green roofs/walls	Green urban equipment*	Green index	Areas that assist pollination**	Access to nature areas	Green area availability	Bicycle and pedestrian routes	Educational gardens and paths	Sudden natural disaster risks ***	Noise	Unified NbS - full potential
Platform	Country/city application examples (if applicable)																																
ThinkNature	England								■			■	■						■			■		■							■	■		
	Portugal	■																				■	■	■										
	France	■															■	■													■	■		
NATURVATION	Malmo		■	■					■						■		■	■	■	■			■	■		■								■
	Barcelona		■	■					■						■		■	■	■	■			■	■		■								■
	Utrecth		■	■					■						■		■	■	■	■			■	■		■								■
UrbanGreenUP	İzmir									■		■			■						■		■				■			■				
	Liverpool					■			■	■											■	■	■				■			■	■			
	Valladolid	■	■			■							■		■	■					■		■	■	■					■	■			
Unalab	Eindhoven		■					■	■			■				■					■		■	■						■				
	Tampere								■												■			■										
	Genova		■									■	■		■						■		■											
NATURVATION	European cities****	■			■	■	■	■		■		■																	■				

* lighting, shading element, barriers etc. ** wall, column, roof etc. *** natural disasters such as flood, fire etc. **** more than 700 European cities

DISCUSSION AND CONCLUSIONS

The environmental problems we are exposed to today and can be evaluated under various titles impact life on a global scale. In this context, there is a need for systems in which nature-human relations are evaluated holistically, not separately. With the understanding of this need, concepts that can solve these problems have been put forward. Efforts are underway to develop frameworks for these concepts, with a new addition added daily. In this study, attention was drawn to the concept of NbS, a relatively new concept that is getting more and more attention in the literature. The development process of NbSs, the different platforms that deal with NbSs and the thematic map layers handled in these platforms, and the importance of GIS-based thematic urban maps in determining the effectiveness of NbSs because they are evidence-based and therefore measurable. Among the platforms examined, four platforms that deal with the map layers that will be effective in examining the effectiveness of NbSs with applied project examples are focused: ThinkNature, UrbanGreenUp, NATURVATION, and Unalab. By examining the projects of the selected platforms, the data that can be used to query the activities of NbSs and the thematic map layers that can be created with these data are determined and presented in a table related to the GIS. When the table obtained as a result of the research is examined, it has been determined that the platform that offers the most visual and questionable data layers is NATURVATION. UrbanGreenUp follows this platform, while ThinkNature and UnaLap offer users a data layer with verbal suggestions about data layers compared to other platforms. With the thematic map layers determined on these platforms, suggestions were made to the users. It was pointed out that presenting these data via GIS-based systems would meet a critical need and provide advantages for planning and design points.

As a result of the examinations and evaluations, the following conclusions were reached within the scope of this study: (1) It has been seen that some map layers were determined in line with the objectives of the projects and scenarios were developed and simulated from these layers in determining the effectiveness of NbS in the platforms and other studies examined within the scope of the study. In this context, thematic map layers are an effective tool in preparing future scenarios for environmental problems and their solutions. (2) Developing alternatives to planning is a very important and complex step in decision processes. Ultimately, which decision will be implemented is also a very important issue. GIS-based Geodesign can be used as an effective tool in inspecting NbSs, as it has a usable structure at all stages of decision processes. (3) With the use and analysis of map layers in scenarios developed for planning, it can produce results that meet the objectives of NbSs. Thus, what needs to be done in order to achieve the results targeted by the projects can be obtained more realistically as quantitative data. (4) MCA (Multi-Criteria Analysis), which allows the evaluation of possible measures with various criteria defined quantitatively and qualitatively in scenarios developed for planning, can be used as an evaluation tool for NbS measurements. (5) Also, one of the important aspects to be considered when determining the framework of map layers in thematic map creation is data availability. It is only possible to create layers, develop and ensure traceability with appropriate data. Studies on data management should be done. (6) Thematic maps will make important contributions to the effective use of NbSs as well as question the effectiveness of NbSs. Evidence-based and traceable NbSs will allow reporting. (7) Presentation of thematic maps on the web enables the results to be observed by larger audiences. This can be an important help in raising awareness about nature-based studies, especially among the local people. (8) Creating awareness through the presentation of thematic maps on the web can be important in ensuring public participation in the planning/design process. (9) Studies on nature-based solutions to environmental problems should be complemented with technology, culture, and behavior-based solutions. In this context, the study deals with nature-based solutions through technology-based solutions. The limited study in the literature reveals a need for more studies on the scope of the subject. As the authors, this study will contribute to the literature in this context.

Ethics Committee Approval: *Ethics committee approval was not required for the methods and data collection tools used in this study.*

Conflict of Interest Statement: *There is no conflict of interest between the authors.*

REFERENCES

Albert, C., Brillinger, M., Guerrero, P., Gottwald, S., Henze, J., Schmidt, S., ... & Schröter, B. (2021). Planning nature-based solutions: Principles, steps, and insights. *Ambio*, 50(8), 1446-1461.

Bush, J. & Doyon, A. (2019). Building urban resilience with nature-based solutions: How can urban planning contribute? *Cities*, *95*(July), 102483. https://doi.org/10.1016/j.cities.2019.102483

Chaolin, G. (2020). Urbanization. In A. Kobayashi (Ed.), *International Encyclopedia of Human Geography* (2nd ed., pp. 141–153).

Çobanyılmaz, P. & Yüksel, Ü. D. (2013). Determination of Vulnerability of Cities to Climate Change: The Case of Ankara. *Suleyman Demirel University Journal of Natural and Applied Science*, *17*(3), 39–50.

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C. R., Renaud, F. G., Welling, R. & Walters, G. (2019). Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, *98*, 20–29. https://doi.org/10.1016/J.ENVSCI.2019.04.014

Cohen-Shacham, E., Walters, G., Janzen, C. & Maginnis, S. (eds. (2016). Nature-based Solutions to address global societal challenges. In E Cohen-Shacham, G. Walters, C. Janzen, & S. Maginnis (Eds.), *Nature-based solutions to address global societal challenges*. https://portals.iucn.org/library/sites/library/files/documents/2016-036.pdf

Dorst, H., van der Jagt, A., Raven, R. & Runhaar, H. (2019). Urban greening through nature-based solutions – Key characteristics of an emerging concept. *Sustainable Cities and Society*, *49*(January), 101620. https://doi.org/10.1016/j.scs.2019.101620

Eggermont, H., Balian, E., Azevedo, M. N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., Van Ham, C., Weisser, W. W. & Le Roux, X. (2015). *Nature-based Solutions: New Influence for Environmental Management and Research in Europe Nature-based Solutions: New Influence for Environmental Management and Research in Europe | GAIA 24/4 (2015): 243-248 Nature-based Solutions, an Emerging Term*. https://doi.org/10.14512/gaia.24.4.9

Ejaro, S. P. & Abubakar, A. (2013). The challenges of rapid urbanization on sustainable development of Nyanya, Federal Capital Territory, Abuja, Nigeria. *Journal of Applied Sciences and Environmental Management*, *17*(2), 299–313.

Frantzeskaki, N. (2019). Seven lessons for planning nature-based solutions in cities. *Environmental Science and Policy*, *93*(December 2018), 101–111. https://doi.org/10.1016/j.envsci.2018.12.033

Frantzeskaki, N., McPhearson, T., Collier, M. J., Kendal, D., Bulkeley, H., Dumitru, A., ... & Pintér, L. (2019). Nature-based solutions for urban climate change adaptation: linking science, policy, and practice communities for evidence-based decision making. *BioScience*, *69*(6), 455-466.

Gottwald, S., Brenner, J., Janssen, R. & Albert, C. (2021). Using Geodesign as a boundary management process for planning nature-based solutions in river landscapes. *Ambio*, *50*(8), 1477-1496.

Hutchins, M. G., Fletcher, D., Hagen-Zanker, A., Jia, H., Jones, L., Li, H., ... & Yu, S. (2021). Why scale is vital to plan optimal Nature-Based Solutions for resilient cities. *Environmental Research Letters*, *16*(4), 044008.

Kabisch, N., Frantzeskaki, N., & Hansen, R. (2022). Principles for urban nature-based solutions. *Ambio*, 1-14.

Korkut, A., Gültürk, P. & Topal, T. Ü. (2016). A Study on Ground Permeability of the Urban Landscape Structures: The Case Study of Tekirdağ. *Kastamonu Uniersity, Journal of Forestry Faculty*, *16*(2), 412–422.

Korkut, A., Kiper, T. & Topal, T. Ü. (2017). Ecological Approaches in Urban Landscape Design. *Artium*, *5*(1), 14–26.

Krauze, K. and Wagner, I. (2019). "From classical water-ecosystem theories to nature-based solutions — Contextualizing nature-based solutions for sustainable city," *Science Total Environment*, 655, 697–706, doi: 10.1016/j.scitotenv.2018.11.187.

Majidi, A. N., Vojinovic, Z., Alves, A., Weesakul, S., Sanchez, A., Boogaard, F. & Kluck, J. (2019). Planning

nature-based solutions for urban flood reduction and thermal comfort enhancement. *Sustainability (Switzerland)*, *11*(22). https://doi.org/10.3390/su11226361

Meerow, S., Newell, J. P. & Stults, M. (2016). Defining urban resilience: A review. *Landscape and urban planning*, *147*, 38-49.

Memisoglu Baykal, T. Colak, H.E. (2021). Producing climate boundary maps using GIS interface model designed with python. *Prog. Phys. Geogr.* https://doi.org/10.1177/03091333211033223.

Memisoglu, T. (2020) Developing the geographical information system interface for green property right defined as environmental disposal restrictions. PhD Thesis, Karadeniz Technical University, Institute of Science, Trabzon.

Mino, E., Pueyo-Ros, J., Škerjanec, M., Castellar, J. A., Viljoen, A., Istenič, D., ... & Comas, J. (2021). Tools for edible cities: A review of tools for planning and assessing edible nature-based solutions. *Water*, 13(17), 2366.

Rahımbaylı, S., & Polat, E. (2021). Landscape Urbanism and Urban Sustainability. In Ş. E. Beşir, M. B. B. Bulut, & İ. Bekar (Eds.), Architectural Sciences and Sustainability (pp. 97–116). Iksad Publications.

Raymond, C. M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M. R., Geneletti, D., & Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, *77*, 15–24. https://doi.org/10.1016/J.ENVSCI.2017.07.008

Ribeiro, P. J. G., & Gonçalves, L. A. P. J. (2019). Urban resilience: A conceptual framework. *Sustainable Cities and Society*, 50, 101625.

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., House, J., Srivastava, S., & Turner, B. (2021). Getting the message right on nature-based solutions to climate change. *Global Change Biology*, *27*(8), 1518–1546. https://doi.org/10.1111/GCB.15513

Somarakis, G., Stagakis, S., & Chrysoulakis, N. (2019). *ThinkNature Nature-Based Solutions Handbook*. https://platform.think-nature.eu/system/files/thinknature_handbook_final_print_0.pdf

Tan, B. A., Gaw, L. Y. F., Masoudi, M. & Richards, D. R. (2021). Nature-Based Solutions for Urban Sustainability: An Ecosystem Services Assessment of Plans for Singapore's First "Forest Town". *Frontiers in Environmental Sciences*, *9*, 610155.

Topal, T. Ü. (2021). Ecology-Based Planning Approach for Urban Development Areas: Tekirdağ Example. Tekirdağ Namık Kemal University. PhD Thesis, Institute of Science, Tekirdağ.

UNDRR, 2021. Words into Action: Nature-based Solutions for Disaster Risk Reduction.

Uttara, S., Bhuvandas, N. & Aggarwal, V. (2012). Impacts of urbanization on environment. International Journal of Research in Engineering and Applied Sciences, 2(2), 1637–1645.

Wang, Z., Huang, L., Xu, M. & Wang, S. (2021). Bridging the science-practice gaps in nature-based solutions: A riverfront planning in China. *Ambio*, *50*(8), 1532-1550.

WEB 1, 2022. https://www.undp.org/sustainable-development-goals, 22 May 2022.

WEB 2, 2022. https://www.think-nature.eu/

WEB 3, 2022. https://naturvation.eu/index.html

WEB 4, 2022. https://naturvation.eu/assessment/maps.html

WEB 5, 2022. https://naturvation.eu/assessment/cities

WEB 6, 2022. https://www.urbangreenup.eu/

WEB 7, 2022. https://www.urbangreenup.eu/cities/)

WEB 8, 2022. https://unalab.eu/en

WEB 9, 2022. https://unalab.eu/en/our-cities/city-basaksehir

WEB 10, 2022. https://platform.think-nature.eu/case-studies

Welden, E. A., Chausson, A. & Melanidis, M. S. (2021). Leveraging Nature-based Solutions for transformation: Reconnecting people and nature. *People and Nature*, *3*, 966–977.

World Bank. (2008). *Biodiversity, Climate Change, and Adaptation: Nature-based Solutions from the World Bank Portfolio*. https://openknowledge.worldbank.org/handle/10986/6216.

World Bank. (2021). *A Catalogue of Nature-based Solutions for Urban Resilience*. Washington, D.C. World Bank Group.

Yomralıoğlu, T. (2000). Geographic Information Systems Basic Concepts and Applications, Seçil Ofset.