

## EVALUATING GREEN AND BLUE INFRASTRUCTURE IN URBAN AREAS IN ROMANIA: A METHODOLOGICAL APPROACH

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### Abstract

*This study explores the potential of implementing analysis indicators in the Romanian context to enhance the development and maintenance of green and blue urban infrastructure. Previous studies on GBUI have primarily focused on larger scales, considering cities or territories, to understand connectivity and positive impacts. However, in Romania, green and blue infrastructure in urban areas has received less attention for analysis and development. To understand the impact of GBUI at a neighbourhood level, the study proposes the development of specific indicators that consider the urban form, functional zoning, and the provision of public urban green and blue spaces regarding housing and urban amenities. This research utilises international practice, scientific literature, and national legislation to understand new mechanisms for urban design and sustainable development. It maps indicators for GBUI analysis and design, contributing to a new methodological approach in the Romanian context. This research's findings can guide the design and development of new residential areas, thereby improving the quality of urban life through improved green and blue urban infrastructure.*

**Key words:** green and blue urban infrastructure, sustainable urban development, sustainable housing, urban areas.

### INTRODUCTION

Over the last few decades, cities have seen an explosion in growth, both in size and population. The projection is that 68% of the global population will live in cities by 2050 (United Nations, 2018). Consequently, cities must address heightened challenges, including demographic growth and climate change.

In understanding the need to link residential neighbourhoods with green and blue infrastructure, we bring into the discussion the European Commission document The New Leipzig Charter, "The transformative power of cities for the common good". Its importance lies in the holistic understanding of cities as complex cities that need to be understood from multiple perspectives: social, environmental, and economic. One of the land-use policy aspects promoted by the document is the balance between urban density and green and blue infrastructure, addressing both environmental and social needs for a better

quality of life for citizens (European Commission, 2020).

Green infrastructure is becoming an increasingly popular topic in Romania. Civil society is a backer of projects in this area. They believe that investment in green infrastructure can provide numerous benefits, including improved air and water quality, increased biodiversity, and more sustainable and livable communities. Green infrastructure initiatives have been developed in both cities and rural communities ("The Civic Groups of Bucharest", 2022; Sebastian, 2023; Alex Găvan Foundation, 2024). However, there is a lack of coordination among these projects, thus their influence is limited.

### Defining urban green and blue infrastructure

The current problems faced by cities, such as global warming, the increase in the number of cars, air pollution, the loss of natural areas, have contributed to the awareness of the

importance of green and blue infrastructure and the benefits they bring.

From the 1990s onward, the term "green infrastructure" has become increasingly prevalent in specialised literature (Popescu & Petrişor, 2020).

In 1994, one of the earliest references to the concept emerged within the efforts of the Florida Greenways Commission, which advocated for a document outlining strategies to advance the development and enhancement of greenways across Florida. In planning new residential developments, alongside transportation and building infrastructure, significant attention should also be directed towards establishing a network of green spaces (Florida Greenways Commission, 1994). A singular park falls short in safeguarding biodiversity, mitigating pollution, facilitating recreation, and fostering social interaction. Therefore, particular emphasis was placed on interconnecting green spaces to optimise the benefits they provide.

Green and blue infrastructures consist of natural and semi-natural areas that offer a large spectrum of ecosystem services (European Commission, 2019). According to the EU, it is vital to support the integration of these infrastructures into strategic urban planning documents. The Natura 2000 sites are a crucial element of the EU's green network. The EU's objectives of environmental conservation, biodiversity, and pollution reduction depend on these areas.

Green and blue infrastructures contribute to economic, ecological, and social well-being, facilitating sustainable urban development and offering spaces that deliver multiple advantages to the local community (Mell, 2009; Town & Country Planning Association, 2004; Pienaru & Rădulescu, 2022).

From a cultural standpoint, green and blue infrastructures fulfil functions such as: direct experience of natural ecosystems, recreation, opportunities for socialisation, environmental education (Aherm, 2007).

## **MATERIALS AND METHODS**

This study is based on an extensive review of Romanian legislation, international documents and policies, and scientific research regarding

green and blue infrastructure, with a focus on urban space. The paper maps GBUI and related concepts in Romania through an analysis of national normative acts. The research used a keyword search of "green infrastructure" and "blue infrastructure" and related elements, such as green spaces, gardens, lakes, rivers, etc., to explore the extent of usage in the legislation. Once the relevant keywords had been determined, they were used to conduct a search on the Romanian Government portal for legislation, JUST (The Romanian Government, 2024). Using a search engine, the syntax "site:legislatie.just.ro keyword" was utilised to conduct broad searches for those laws that contained the searched keywords. An exception to this type of analysis were the Guidelines for the preparation of urban planning documents, which can only be found in scanned digital versions that do not permit optical character recognition (Ministry of Development, Public Works and Administration, 2020).

## **RESULTS AND DISCUSSIONS**

### **The interest for Green and Blue Urban Infrastructures in European Union**

At the level of the European Union, there is a strong interest in reducing pollution levels and achieving sustainable development goals. In this regard, several concepts have been mentioned in official EU documents that can play an important role in improving the quality of the environment. The "European Green Pact" is the document that lays the foundations for transforming the EU economy by reducing the use of non-renewable natural resources and eliminating greenhouse gases by 2050 (European Commission, 2019). At the same time, the document highlights the need for all countries to work together and take action to achieve the proposed targets. It stresses the importance of involving as many countries as possible to achieve the desired results, with the aim of slowing down global warming and its impact on everyone. The document sets out the instruments for making the European economy cleaner. Among the terms used, the term "blue economy" stands out. The term considers the benefits offered by the world's seas and oceans in terms of offshore renewable sources

(European Commission, Joint Research Centre, 2019).

It also considers solutions to mitigate the effects of climate change on specific flora and fauna. Fishing and aquaculture are important economic activities, but they have significant environmental impacts. Such activities need to be carried out, taking into account the impact on local communities in coastal areas. Another concept used in the European Green Deal is "green investment", which aims to reduce environmental impacts. Areas where green investment is strongly encouraged are transport and energy. In addition to environmental impacts, green investments can lead to the creation of new jobs and the development of new technologies (European Commission, 2019).

The increased interest at EU level in reducing pollution is also reflected in the way European funding is allocated. The Regional Operational Programmes allocate significant amounts of funding to the creation of new green infrastructure and the improvement of existing infrastructure. Actions eligible for funding include the conversion of degraded or derelict land into green spaces and the creation of urban forests.

According to the Western Regional Operational Programme, green infrastructure includes forests, ponds and flowering meadows. Green infrastructure is an effective way to improve people's quality of life by reducing the effects of pollution (increasing air quality, reducing noise pollution, mitigating microclimate) (Western Regional Development Agency, 2021). All these benefits make green infrastructure an essential tool in the development of cities. At the community level, green infrastructure can increase local attractiveness by fostering connections between residents (Western Regional Development Agency, 2021). Another advantage is the support of biodiversity through the repopulation and protection of local species, aimed at rejuvenating troubled areas.

The "Guidance on a strategic framework for further supporting the deployment of EU-level green and blue infrastructure" is another European Commission document that highlights the role of green and blue urban infrastructure in halting the trend of declining

air, water, and soil quality and biodiversity loss. In addition to the environmental and health benefits for the population, green and blue infrastructures imply social and economic benefits. At an urban level, GBUI provides the residents with recreational facilities, and children have more places to play. Urban green and blue infrastructures are networks consisting of natural and semi-natural areas that provide ecosystem services, impacting people's quality of life (European Commission, 2022). In addition to these aspects, green and blue infrastructures include highly biodiverse ecosystems, parks, gardens, green roofs, hedgerows, ponds, meadows, as well as abandoned areas given back to local communities. At the heart of these infrastructures are Natura 2000 sites and the network they form across the European Union. In the long term, the aim is to connect these protected areas, as many of them are isolated, which has negative effects on wildlife (European Commission, 2022).

### **The Green and Blue Urban Infrastructures as urban amenity in Romanian residential areas**

Urban planning practice in Romania acknowledges the importance of public green spaces in relation to the development of cities and, implicitly, residential areas (Law No. 350 of 6 July 2001). Socialist planning practice (before the change of political regime in 1989) stresses the importance of designing the new residential estates taking into account green spaces in conjunction with the urban amenities needed for day-to-day life (Lăzărescu, 1977; Laurian, 1965).

In present Romanian practice, the green space area of residential neighbourhoods is not defined by urbanistic indicators in connection with urban density, yet some local urban guidelines suggest percentages of plot area. The General Urban Code, under Annex 6, "Green and Planted Spaces", does not specify the percentage of green space required in residential neighbourhoods, just that at least 2 square metres of green space be provided for each inhabitant (Government Decision No. 525 of 27 June 1996). This annex is defined in paragraph 6.8. for dwellings a minimum of 2 square metres per inhabitant, but it is not

specified for which type of dwelling. It is also not specified what type of green space is taken into account, where it is placed (private courtyards or public parks), and what is the maximum distance green space - dwelling. Nevertheless, this value is well below the European Commission's recommendation of 26 square metres per inhabitant. An additional issue is the process of reporting and measuring the area of green space, due to the lack of adaptation to each individual city targeted for research (Badiu et al., 2016). Although it currently exists in the form of a proposal, it should be noted that the proposed law, "Code of Territorial Planning, Urban Development and Construction" (CATUC), presents a definition of residential areas linking the housing function and green spaces of public character and urban amenities.

The analysis of the 13 normative acts, i.e. 56 articles, sections and annexes, resulted in 28 key words. Some of these keywords were previously established for the identification of normative acts, such as green infrastructures, blue infrastructures, green spaces, waterways, etc. They refer to the type of concepts that are regulated. The second type of key word resulting is that of regulated aspects. Following comparative analyses: definitions of concepts; role of concepts; development of urban

infrastructures: green, blue or both; urban planning documents; norming areas at urban level; norming areas at plot level; norming ancillary functions; norming constructions on GBUI; special situations: protected areas of historical monuments; responsible for maintenance and protection; prohibition of change of use; and contraventions.

### Types of Green and Blue Urban Infrastructures

To better understand and analyse the Green and blue urban infrastructure, we examined its urban features. Thus, Table 1 shows the identification of items based on their type: green or blue.

In an urban context, green infrastructure can include parks, gardens, trees, and other natural elements that provide environmental benefits such as air purification and temperature regulation (Czechowski et al., 2018). On the other hand, blue infrastructure can consist of water bodies such as rivers, lakes, and ponds that play a crucial role in managing stormwater and providing recreational opportunities (Brears, 2018). By classifying these items as green and blue, we aim to assess the overall impact of urban infrastructure on the environment and the community in Romanian cities.

Table 1. Identification of types of Green and Blue Urban Infrastructures

GBUI element	Type	Source
lake	blue	Mell & Scott, 2023; Jones et al., 2022
green roof	green	Almaaitah et al., 2021; Mell & Scott, 2023; Abhijith et al., 2017; Castleton et. al., 2010; Baik et al., 2012; Hamel & Tan, 2022; Radinja et al., 2021
permeable pavement	green	Almaaitah et al., 2021; Afonso et al., 2018; CNT, 2010
bioswale	green	Almaaitah et al., 2021; Hamel & Tan, 2022; Jones et al., 2022; Radinja et al., 2021; CNT, 2010
rainwater tanks	blue	Almaaitah et al., 2021
blue roof	blue	Almaaitah et al., 2021; Shafique et al., 2016
rainwater storage under buildings	blue	Almaaitah et al., 2021
public garden	green	Mell & Scott, 2023; Jones et al., 2022
pocket park	green	Mell & Scott, 2023; Hamel & Tan, 2022
river front	green	Mell & Scott, 2023

pond	blue	Mell & Scott, 2023; Jones et al., 2022; Radinja et al., 2021
green wall	green	Mell & Scott, 2023; Abhijith et al., 2017; Jones et al., 2022
trees	green	Abhijith et al., 2017
urban park	green	Mell & Scott, 2023; Jones et al., 2022
hedge	green	Abhijith et al., 2017
urban forest	green	Escobedo et al., 2011; Kuehler et al., 2017; CNT, 2010
green tram tracks	green	O'Donnell et al., 2021; Sikorski et al., 2018; Major et al., 2023; Rendeková et al., 2022;
buffer vegetation strips	green	Wagner et al., 2013
infiltration systems	blue	Wagner et al., 2013
rain garden	green and blue	Hamel & Tan, 2022; Jones et al., 2022; Radinja et al., 2021
amenity areas	green and blue	Jones et al., 2022
canal	blue	Jones et al., 2022
estuary	blue	Jones et al., 2022
green wedges	green	Frey, 1999
sport facilities	green	Lăzărescu, 1977

### Analysis Indicators for Green and Blue Urban Infrastructures

The creation of indicators to measure and analyse GBUI can facilitate ongoing monitoring and potential for improvement. The proposed categories of indicators were identified in various studies and existing models that emphasise the significance of GBI in areas such as ecosystem services, health demands (Pakzad & Osmond, 2016), social requirements (Rundle et al., 2013), and cultural aspirations.

Table 2 provides a comprehensive list of indicators we identified and categorized according to their relevance to: economic, health, social, environmental. These indicators can offer valuable insights into the

effectiveness of GBUI interventions and identify areas for improvement for policymakers and stakeholders. The indicators are useful for comparing project outcomes between regions and raise awareness of emerging challenges. Regular monitoring of these indicators will facilitate a more comprehensive approach to GBUI planning and management, ultimately leading to a more sustainable and liveable urban environment. The indicators identified are mostly in the environmental category, with a few related to social, health, and economic aspects as well. Taken as a whole, these indicators provide a comprehensive understanding of the various ways GBUI impacts the environment and society.

Table 2. Analysis Indicators for Green and Blue Urban Infrastructures

Indicator	Measurement	Type	Source
surface of green infrastructure	quantitative	environmental/ health	Dlugonski & Szumanski, 2015
infiltration capacity	quantitative	environmental	Boogaard et al., 2023
air temperature	quantitative	environmental/ health	Bartasaghi Koc et al., 2018

soil temperature	quantitative	environmental	Bartesaghi Koc et al., 2018
relative humidity	quantitative	environmental	Bartesaghi Koc et al., 2018
surface albedo	quantitative	environmental	Bartesaghi Koc et al., 2018
vegetation arrangement	qualitative	environmental	Bartesaghi Koc et al., 2018
plant species	qualitative	environmental	Bartesaghi Koc et al., 2018
evapotranspiration rate	quantitative	environmental	Bartesaghi Koc et al., 2018
soil quality	qualitative	environmental/ health	McKinney, 2006; Zhu & Carreiro, 2004, cited by Pakzad & Osmond, 2016
improve accessibility	qualitative	health/ social	Rundle et al., 2013 cited by Pakzad & Osmond, 2016
noise level	quantitative	environmental/ health	CNT, 2010
potable water use	quantitative	environmental/ health	CNT, 2010
flood risk	qualitative	environmental/ economical/ social/ health	CNT, 2010; Rayan et al., 2021
food production (urban agriculture)	quantitative/ qualitative	social/ economic	Rayan et al., 2021
usage of private car	quantitative	environmental/ economic	Rayan et al., 2021
energy consumption for cooling and heating demands	Quantitative	economic	Rayan et al., 2021
healthcare cost	Quantitative	economic/ health/ social	Rayan et al., 2021
accessibility to public parks gardens and playgrounds	Quantitative	environmental/ social	Wang et al., 2019
pollutants removed by vegetation	Quantitative	environmental/ health	Wang et al., 2019
temperature decrease by tree cover	Quantitative	environmental	Wang et al., 2019
employment resulting from green infrastructure initiatives	quantitative/ qualitative	economic/ social	Wang et al., 2019
semi-natural surfaces providing ecological benefits	quantitative/ qualitative	environmental	Ioja et al., 2014

## CONCLUSIONS

Studies have demonstrated that green infrastructure helps to lessen the adverse effects of urbanisation (Tache et al., 2023; Petrișor et al., 2022; Popescu et al., 2022; Badiu et al., 2016). However, efficient coordination and collaboration amongst various stakeholders -

including government agencies, community organisations, and the corporate sector- are essential to realising the full potential of green infrastructure. With the issues brought on by air pollution getting worse (Ilie et al., 2023), there is an increasing need for a healthier environment (Eijck et al., 2017). In order to enhance their general well-being and spend

time in nature in the most enjoyable and healthful setting, city inhabitants require more urban green and blue infrastructure (Hajer et al., 2020).

Cities have the potential to create areas that not only offer recreational possibilities but also enhance air quality and minimise the effects of climate change by incorporating green infrastructure into urban design and development (Mell, 2019).

Although the current Romanian body of legislation contains numerous legislative acts dealing with the subject of green urban infrastructure and related concepts, there is no unified approach and coherent definition. In the absence of a clear definition, the concept of green urban infrastructure is used in several normative acts in different situations: in the context of the digitization and improvement of urban planning documentation (Romania's Urban Policy, 2022), of the motivation for the elaboration of some projects of urban regeneration (Specific Guidelines from 10 May 2022, on conditions for accessing European funds related to the National Recovery and Resilience Plan under calls for projects NRP/2022/C10, component 10. It is noted that it was also used erroneously, with reference to green energies, within Emergency Ordinance No. 183 of 28 December 2022.

One of the biggest problems identified is related to the definition provided by the future Code of Territorial Planning, Urban Development and Construction. The definition offered partially takes over the definition of the European Commission, but the specifications regarding the quality of the environment, the improvement of the lives of the inhabitants, and the advantages offered by the green economy have been eliminated (Ministry of Development, Public Works and Administration, 2023; European Commission, 2022). In this sense, there is a lack of complexity in the definition, with negative effects on the future.

GBUI needs to be considered within the complex urban system, as recent interest in reformulated urban concepts such as the 15-minute city has shown.

Urban strategies developed by cities such as Paris (Cities100, 2019), Milan (Sanesi et al., 2017), or Barcelona (Magrinyà et al., 2023)

emphasise the importance of accessibility and the provision of green and blue spaces. We can therefore observe that GBUI cannot be considered as a whole without taking into account aspects such as housing density in relation to pedestrian mobility, the link between infrastructure and urban amenities, environmental and ecological or economic and cultural needs.

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