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Luís Valença PINTO

DOCTORAL DISSERTATION

A DATA-BASED FRAMEWORK FOR EFFICIENT URBAN GREEN SPACE MANAGEMENT – CONTRIBUTIONS FROM SOCIO-ENVIRONMENTAL SCIENCES

SOCIAL SCIENCES,
MANAGEMENT (S 003)
VILNIUS, 2025

MRU
Mykolas Romeris University

MYKOLAS ROMERIS UNIVERSITY

Luís Valença Pinto

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Scientific supervisor:

Prof. Dr. Paulo Pereira (Mykolas Romeris University, Social Sciences, Management, S 003).

Scientific co-supervisors:

Prof. Dr. António Dinis Ferreira (CERNAS – Research Center for Natural Resources, Environment and Society, Portugal);

Prof. Dr. Sander Jacobs (INBO – Institute for Nature and Forest, Belgium).

The doctoral thesis is defended in the Management Science Council of Vytautas Magnus University, Klaipėda University, Mykolas Romeris University, and Vilnius University Šiauliai Academy:

Chairperson:

Prof. Dr. Tadas Sudnickas (Mykolas Romeris University, Social Sciences, Management, S 003).

Members:

Prof. Dr. Ramūnas Povilanskas (Klaipėda University, Natural Sciences, Physical Geography, N 006);

Prof. Dr. Ligita Šimanskienė (Klaipėda University, Social Sciences, Management, S 003);

Assoc. Prof. Dr. Miguel Villoslada (University of Eastern Finland, Finland, Natural Sciences, Ecology and Environmental Science, N 012);

Prof. Dr. Jan Žukovskis (Vytautas Magnus University, Social Sciences, Management, S 003).

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Address: Didlaukio str. 55, 08303 Vilnius, Lithuania.

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Luís Valença Pinto

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Mokslinis vadovas:
prof. dr. Paulo Pereira (Mykolo Romerio universitetas, socialiniai mokslai, vadyba, S 003).

Moksliniai konsultantai:
prof. dr. António Dinis Ferreira (CERN – Gamtos išteklių, aplinkos ir visuomenės tyrimų centras, Portugalijos Respublika);
prof. dr. Sander Jacobs (INBO – Gamtos ir miškų institutas, Belgijos Karalystė).

Mokslo daktaro disertacija ginama Vytauto Didžiojo universiteto, Klaipėdos universiteto, Mykolo Romerio universiteto ir Vilniaus universiteto Šiaulių akademijos vadybos mokslo krypties taryboje:

Pirmininkas:
prof. dr. Tadas Sudnickas (Mykolo Romerio universitetas, socialiniai mokslai, vadyba, S 003).

Nariai:
prof. dr. Ramūnas Povilanskas (Klaipėdos universitetas, gamtos mokslai, fizinė geografija, N 006);
prof. dr. Ligita Šimanskienė (Klaipėdos universitetas, socialiniai mokslai, vadyba, S 003);
doc. dr. Miguel Villoslada (Rytų Suomijos universitetas, Suomijos Respublika, gamtos mokslai, ekologija ir aplinkotyra, N 012);
prof. dr. Jan Žukovskis (Vytauto Didžiojo universitetas, socialiniai mokslai, vadyba, S 003).

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Adresas: Didlaukio g. 55, 08303 Vilnius.

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LIST OF ACRONYMS

APA	Agência Portuguesa do Ambiente (Portuguese Environmental Agency)
BASE	Bielefeld Academic Search Engine
B-On	Biblioteca do Conhecimento Online [Online Library of Knowledge]
CES	Cultural Ecosystem Services
CF	Cohesion Fund
CICES	Common International Classification on Ecosystem Services
CLLD	Community Led Local Development
COVID-19	Coronavirus Disease 2019
CVM	Contingent Value Method
DOAJ	Directory of Open Access Journals
EC	European Commission
EDS	Ecosystem Disservices
EFA	Exploratory Factor Analysis
EIB	European Investment Bank
EPA	Environmental Protection Agency
ERC	European Investment Bank
ERDF	European Regional Development Fund
ES	Ecosystem Services
ESF+	European Social Fund
ESIF	European Structural and Investments Funds
EU	European Union
EU-27	The current group of 27 European Union countries
FUA	Functional Urban Areas
GBI	Green and Blue Infrastructure
GI	Green Infrastructure
GIS	Geographical Information System
GSG	Green space governance
ITI	Integrated Territorial Instruments
IUCN	International Union for Conservation of Nature
JSTOR	Journal Storage (electronic archive)
JTF	Just Transition Fund
KPI	Key performance indicators
LAP	Local Action Plan
MAES	Mapping and Assessment of Ecosystem Services
NCD	Non-communicable disease
NGO	Non-governmental organization
NPG	New Public Governance
OSM	Open Street Map
OTT	Other Territorial Tools
PO	Policy objective

PPGIS	Public Participation Geographic Information System
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
PUPA	Public Urbanism Personal Architecture
SDG	Sustainable Development Goals
SO	Specific Objective
TPA	Traditional Public Administration
UGBI	Urban Green and Blue Infrastructure
UGS	Urban Green Spaces
UIA	Urban Innovative Actions
UK	United Kingdom
UN	United Nations
UN-SDG	United Nations' Sustainable Development Goals
USA	United States of America
WHO	World Health Organization
WTP	Willingness to Pay

ABSTRACT

The sustainable development of cities worldwide is under constant pressure due to the fast-growing urban population and increased climate change issues, both in frequency and intensity (e.g., heat waves or intense rainfall events). This pressure is also felt on urban green spaces (UGS), considered by the United Nations (UN) as key elements for urban sustainability and human well-being. Their relevance is linked to the diversity of ecosystem services (ES) they provide, contributing, e.g., to the regulation of local climate and water flows (Regulating ES), the provisioning of materials and food (Provisioning ES), and the availability of nature-based cultural services (Cultural ES).

Under these circumstances, the efficient management of UGS gains increased relevance. Accurate and up-to-date data are essential for any efficient management process. However, access to relevant, detailed, and useful data is one of the key issues affecting the management of these spaces. Several frameworks have been proposed for the management of UGS. However, data collection needs and methods to support informed management decisions oriented towards sustainable development, distributional and participatory justice, and improved human well-being are absent.

This article-based dissertation intends to contribute to the management field from the perspective of socio-environmental science, which is linked to the sustainable management of UGS. One base assumption for this work is the understanding that rigorous and relevant data are the backbone of any efficient management process. This contribution is based on assessing data collection methods, focusing on the optimization of data collection and providing relevant and comprehensive information on preferences for the use of UGS and associated CES and well-being benefits. The results from this assessment were the basis for the proposal of a new data-based framework to support UGS management practices addressing relevant topics like accessibility and environmental justice, community engagement, sustainability, climate change resilience and adaptation, and adequate funding research. Based on local data, the framework is flexible in adapting to different realities and locations.

The developed work contributes to advancing knowledge of the complexity of human-nature relations in the urban environment in a European context while promoting a multisectoral approach linking social geography, environment, and management science fields. The proposed framework offers a hopeful outlook for the future of European cities towards achieving sustainable and equitable management of UGS.

KEYWORDS

Urban green spaces, cultural ecosystem services, human well-being, UGS management, data needs, data-based framework.

LIST OF ORIGINAL PUBLICATIONS

Based on articles, this dissertation is constituted by this manuscript and eight original papers, all published in peer-reviewed scientific journals, seven of which have Impact Factor, as identified in the list below (in parenthesis). The papers are referred to in this manuscript as Studies 1 to 8. The contribution from the author is indicated in parentheses and italics (≈%). Detailed contributions per article are presented on the next page.

1. Pinto, L.V., Inácio, M., Ferreira, C.S.S., Ferreira, A.D., Pereira, P. (2022). Ecosystem services and well-being dimensions related to urban green spaces – A systematic review. *Sustainable Cities and Society* 85, 104072. https://doi.org/10.1016/ j.scs.2022.104072 (**IF: 11.7**). (≈*95%*).
2. Pinto, L.V., Inácio, M., Pereira, P. (2023). Green and Blue Infrastructure (GBI) and Urban Nature-based Solutions (NbS) contribution to human and ecological wellbeing and health. *Oxford Open Infrastructure and Health* ouad004. https://doi.org/ 10.1093/ooih/ouad004. (≈*95%*).
3. Pinto, L.V., Ferreira, C.S.S., Inácio, M., Pereira, P. (2022). Urban green spaces accessibility in two European cities: Vilnius (Lithuania) and Coimbra (Portugal). *Geography and Sustainability*. https://doi.org/10.1016/j.geosus.2022.03.001 (**IF: 9.7**). (≈*80%*).
4. Pinto, L., Ferreira, C.S.S., Pereira, P. (2021). Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal). *Science of The Total Environment* 792, 148293. https://doi.org/10.1016/j.scitotenv.2021.148293 (**IF: 9.8**). (≈*95%*).
5. Valença Pinto, L., Inácio, M., Pereira, P. (2023). Observation-based data-gathering method to support the assessment of the use of cultural ecosystem services in urban green spaces. *MethodsX 11*, 102326. https://doi.org/10.1016/j.mex. 2023.102326 (**IF: 1.9**). (≈*95%*).
6. Pinto, L. V., Inácio, M., Bogdzevič, K., Kalinauskas, M., Gomes, E., & Pereira, P. (2023). Factors affecting cultural ecosystem services use in Vilnius (Lithuania): A participatory mapping survey approach. *Heliyon,* e15384. https://doi.org/10.1016/ j.heliyon.2023.e15384 (**IF: 4.0**). (≈*55%*).
7. Pinto, L.V., Ferreira, C.S.S., Pereira, P. (2024). Temporal and spatial differences in human activities performed in urban green spaces of Vilnius (Lithuania). Geogr. Sustainability. S2666683924000245. https://doi.org/10.1016/j.geosus.2024.03. 002. (**IF: 9.7**). (≈*95%*).
8. Valença Pinto, Pereira, P. (2024). Relevant landscape components in a large urban green space in Oporto (Portugal). Submitted to *Urban Forestry and Urban Greening*. https://doi.org/10.1016/j.ufug.2024.128421 (**IF: 6.4**). (≈*95%*).

AUTHOR'S CONTRIBUTIONS

The author contributed to the different articles as stated below:

1. Pinto contributed to all the tasks set for the paper, including defining the scope and criteria for identifying reviewed papers, conducting an online document search, screening articles, conducting a systematic review and classification of selected papers, producing figures, and writing the manuscript draft (contribution: ≈95%).
2. Pinto contributed to all the paper's tasks, including the literature review, the preparation of the figures, and the writing of the manuscript draft (contribution: ≈95%).
3. Pinto contributed to all the tasks needed for preparing the article, including defining the study's initial concept, running the accessibility analysis, preparing figures, and writing the manuscript draft (contribution: ≈80%).
4. Pinto contributed to all the tasks involved in preparing the article, including conceptualising and implementing the study's methodology, coding the mobile app used for the field survey, organising and implementing the face-to-face field survey, performing the statistical analysis of the data, preparing figures, and writing the manuscript draft (contribution: ≈95%).
5. Pinto contributed to all the tasks involved in preparing the article. These included defining the database structure, preparing and coding the mobile app, defining and integrating coding conventions, optimisation rules, fieldwork guidelines, preparing the images, and writing the manuscript draft (contribution: ≈95%).
6. Pinto performed the statistical analysis, interpreted the data, prepared figures, and drafted the manuscript (contribution: ≈55%).
7. Pinto contributed to all the tasks involved in preparing the article, including defining the study concept, defining the fieldwork methodology, organising and implementing the fieldwork using the app developed in study 6, performing the statistical analysis of the data, preparing figures, and writing the manuscript draft (contribution: ≈95%).
8. Pinto contributed to all the tasks involved in preparing the article, including conceptualising and implementing the study's methodology, preparing the mobile app used for the on-site survey, organising and implementing the fieldwork, performing the statistical analysis of the data, preparing figures and writing the manuscript draft (contribution: ≈95%).

1. INTRODUCTION

1.1 Relevance of the research

Urban areas across the world are faced with increasing challenges due to urban population growth and climate change. The latter include an increase in the frequency and number of extreme weather events (Mishra et al., 2015; Lin et al., 2021), e.g., intense rainfall episodes leading to flash floods (Güneralp et al., 2015) and episodes of heatwaves, adding extra stress to green areas (Huang et al., 2019). These events have high economic and social consequences. Social costs have also increased due to the global trend of urban population growth. In 2006, we reached 50% of the world population living in urban areas (UN- DESA, 2019), with UN projections foreseeing this number to rise to 68.4% by 2050 (UN-Habitat, 2022).

Urban green spaces are fundamental elements of the urban fabric, providing an array of ecosystem services to urban dwellers. UGS can be considered all urban areas covered with vegetation or water, which can include, among others, public parks, forests, street trees, cemeteries, vegetated riverbanks, streams, lakes, ponds, or greenways (Vargas-Hernández et al., 2018). ES are divided into three large sections: provisioning ecosystem services (PES), e.g., drinking water, food, and fibres; regulating ecosystem services (RES), e.g., flood, noise, temperature, or air quality regulation; and cultural ecosystem services (CES), e.g., recreational, and experiential activities (Haines-Young & Potschin, 2018).

The United Nations (UN) recognises the global dimension and relevance of UGS for sustainability in its Sustainable Development Goals (SDGs) (UN, 2020). Given their increasing importance, UGS management gains an augmented relevance. However, how can we ensure the effective management of UGS considering these sustainability issues?

Extensive research has been focused on the issues and limitations related to the management of UGS. These include, among others, lack of funding and resources (e.g., Costadone and Vierikko, 2023), improper planning and management (e.g., Aly and Dimitrijevic, 2022), accessibility and environmental equity issues (e.g., Galdino et al., 2022), lack of detailed and relevant data to support decision-making (e.g., Feltinowski et al., 2018), climate change and environmental impacts (e.g., Lindholst et al., 2016) and community engagement and participation (e.g., Latinopoulos, 2022).

According to management science, efficient management requires knowledge of various complementary fields (Zakarevičius, 2013). On the other hand, data collection and analysis have always been at the base of effective management processes. Management as a scientific discipline is formed by collecting data from practical experience, analysing it, summarising it, and drawing objective conclusions (Zakarevičius, 2013).

Considering the above and the impact of data accessibility on many of the other identified limitations (e.g., improper planning and management, climate change and environmental impacts, or community engagement and participation), we believe that

access to detailed and accurate data should be the backbone of any UGS management framework. Furthermore, the environmental and social relevance of UGS for the sustainable and equitable development of urban areas highlights the critical role of socio-environmental sciences in providing relevant information for the management of these spaces.

1.2 Research problem

Traditional management theories have evolved over time, e.g., with the role of the citizen shifting towards a more empowered participation (Guogis et al., 2012; Mordhah, 2020; Osborne, 2010). But management must adjust to a more dynamic view of the knowledge needs regarding societal and psychological characteristics and needs associated with public space management, reassessing their relevance for the management process (Gifford and Sussman, 2012).

Green space governance (GSG) has gained adhesion across Europe, supported by policies, research and citizens (Hansen et al., 2023). This approach considers the need to address issues related to sustainability, accessibility and environmental justice, community engagement, and climate change resilience and adaptation.

Nevertheless, there are often mismatches between UGS management options and UGS preferences, with some aspects relevant to UGS users either being overlooked or overestimated by management professionals (Ugolini et al., 2022). Cases have been registered where data on people's perception and preferences for UGS and related CES are not identified as relevant by UGS managers (Bell et al., 2007, Sörensen et al., 2021).

As such, improved data management and cross-disciplinary skills are needed to interpret diverse data, align UGS management with user needs and preferences, and integrate strategy with data collection (Sörensen et al., 2021, Ugolini et al., 2022).

Science can provide innovative work in this arena, e.g., by testing different data collection methods. However, from the assessed literature, no framework for the management of UGS has specifically identified nor addressed data needs and data collection methods related to users' preferences for UGS and associated ES.

1.3 Goal of the research

This dissertation aims to define a novel data-based framework to support sustainable UGS management, with a detailed data-collection module designed to provide relevant information on user preferences related to ES. This module includes the definition of data collection methods focused on providing information on relevant variables associated with UGS preferences through a multi-disciplinary approach linking management and socio-environmental sciences.

1.4 Objectives of the research

To achieve the aim of this dissertation, several main objectives were set for the research, namely:

1. To assess and test different data acquisition processes regarding the collection and treatment of socio-environmental data related to the use of UGS,
2. To identify relevant social and environmental variables and factors affecting the preferences for the use of UGS, associated cultural ecosystem services and well-being benefits,
3. To integrate this knowledge of data collection methods and variables influencing user preferences into a practical and efficient framework for data collection and assessment, reducing the gap between management goals and user preferences.

1.5 Research methodology

Literature and systematic reviews were the basis for several methodological steps. They supported (a) the assessment of the relevance of UGS for sustainable urban development and (b) the identification of critical issues related to the management of UGS. They also supported selecting (c) relevant socio-demographic, environmental, and well-being variables related to preferences for using UGS and ES-related activities, and (d) efficient data-collection methods for gathering information on these variables.

Selected data collection methods, including on-site face-to-face surveys, online Public Participation Geographic Information System (PPGIS) surveys, and on-site observation surveys, were used to design fieldwork campaigns to collect data related to the selected socio-demographic and environmental variables.

After data collection, qualitative and quantitative methods were used to assess the relevance of the different variables and identify important factors resulting from the complex interaction between them.

The results from the previous steps provided the ground information for defining the data-based framework. The data collection methods, relevant variables, and resulting factors fed the data collection module, which is the backbone of the management framework.

Relevant insights into key social and environmental issues resulting from the qualitative and quantitative assessment were also integrated into designing the different action modules and associated actions composing the management framework.

A more detailed description of the methodology can be found in section 3.2. (Working methods).

1.6 Scientific novelty and value of the research

The main scientific novelty of this research is the proposal of a new data-based framework for the sustainable management of UGS, which includes a data-collection

module specifically designed to provide relevant information on user preferences related to ES. One of the key aspects of this approach is the ability to assess and integrate social user preferences on the use of UGS and associated CES and associated well-being benefits.

The multidisciplinary approach, linking management and socio-environmental science fields by integrating methods and concepts from the latter, adds richness to the analysis and results.

The data collection model adds flexibility and adaptability to the data-based management framework, supporting informed decisions for resilient, equitable, and multifunctional UGS. Being grounded in local data, the framework is flexible and can be adapted to different realities and locations.

This research offers tangible solutions for urban planners and policymakers by addressing challenges in urban densification, climate change adaptation, financing, and funding.

Another scientific novelty of the research is the development of a specific data-gathering methodology based on observations. This method ensures the swift and precise collection of data on the usage of UGS. Its applicability in diverse urban, cultural, and geographic contexts provides policymakers and urban planners with relevant and detailed data, instilling confidence in the reliability of the research findings.

The developed work contributes to advancing knowledge of the complexity of human-nature relations in the urban environment in a European context while promoting a multisectoral approach linking social geography, environment, and management science fields. The proposed framework offers a hopeful and optimistic outlook for the future of European cities towards achieving sustainable and equitable management of UGS.

2. THEORETICAL BACKGROUND

2.1 Urban green spaces, ecosystem services, and sustainability

UGS are often integrated into the concept of Urban Green and Blue Infrastructure (UGBI) or just Urban Green Infrastructure (UGI). UGBI includes green spaces and water elements in urban areas (Puppim de Oliveira et al., 2022), ranging, e.g. from derelict vegetated land to forest areas and lakes. UGS are considered fundamental spaces for human well-being, given their role as privileged – and often unique – areas for nature contact in the urban environment (Andersson et al., 2014). They are also considered relevant, given the high diversity of provided ES compared to other UGS types (Haase et al., 2014).

This diversity is also relevant for sustainability, as identified in the UN SDGs (United Nations, 2020). The Brundtland report defines Sustainable development as the "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (United Nations, 1987). UGS's relevance for human well-being is strongly linked to the ES they can provide, being recognised in several of the UN's SDG through the provision of a large and diverse ES in all three sections of Provisioning, Regulating, and Cultural services, as defined in the Common International Classification of Ecosystem Services (CICES v5.1) classification (Haines-Young & Potschin, 2018). They are particularly relevant for SDG 11 on Sustainable cities and communities, more specifically for target 11.7, aiming to "provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities" (United Nations, 2015). UGS is also relevant to SDG3 (Good Health and Well-being), namely, target 3.4, aiming to "reduce by one-third pre-mature mortality from non-communicable diseases (NCDs) through prevention and treatment, and promote mental health and well-being" (United Nations, 2015). SDG 11 is also directly linked to the United Nations' New Urban Agenda, launched in 2017, which states that UGS should "make cities inclusive, safe, resilient and sustainable" (United Nations, 2017). The New Urban Agenda Illustrated Handbook highlights UGS's relevance in urban areas (UN-Habitat, 2020).

Further documents at different global and regional levels attest to the relevance of UGS for the sustainable development of urban areas and biodiversity maintenance across the globe. For example, the World Health Organization (WHO) argues that recreational UGS are essential in promoting well-being, equity, and social integration (WHO, 2017). The New Leipzig Charter (EU2020.de, 2020), or the European Union Biodiversity Strategy for 2030 (European Commission, Directorate-General for Environment, 2021), advocate for UGS at the European level. Executive Order 14008 of January 27, 2021, from the USA, identifies environmental and economic justice as critical considerations in the country's governance (Presidential Office, 2021). The sustainable and prosperous goals in China's 14th Five-Year Plan (2021-2025) promote a

balanced, green, equitable, and inclusive growth of both economic and social systems (Asian Development Bank, 2021).

Nonetheless, although the recognition of the link between UGS and human well-being is consensual, the relation between the diversity of ES provided by different UGS and well-being in all its dimensions – for which we adopt a set of dimensions based on the CICES v4.3 document (Haines-Young, 2013): Freedom of choice and action, Mental Health, Physical Health, Good social relations, Food security, and Physical security – lacks a deeper understanding. While UGS can contain a wide diversity of typologies, these different typologies can provide different ES and affect well-being in distinctive ways (e.g., Wood et al., 2018). Most literature on ES provided by UGS is often centred on a single well-being dimension (e.g., Birch et al., 2020, focused on mental health, or Łaszkiewicz et al., 2018, focused on freedom of choice and action) or on a limited set of well-being dimensions (e.g., Lamond & Everett, 2019, focused on mental and physical health and social relations).

Environmental justice, or equity, is also an essential aspect of sustainability in all previously mentioned documents. New UGS projects tend to raise housing market value in the surrounding area, contributing to the displacement of lower-income households, a process known as gentrification (Kim et al., 2022). This process often leads to social exclusion and inequality (Pearsall & Eller, 2020). According to Amdur and Yeung (2021), the term' equity' is linked to fairness and justice. Each person has different origins, possibilities, and limitations, which we must acknowledge and for which we must adjust for possible imbalances. Equity in the planning and implementation of UGS refers to the fair involvement and distribution of outcomes for all stakeholders affected by these actions. Race, gender, socioeconomic status, socio-cultural worldviews, and belief systems must be considered (Bremer et al., 2021). Such socio-demographic variables have been found to influence user preferences in using UGS and CES-related activities (e.g., Basu & Nagendra, 2021; Ode Sang et al., 2020). Equity encompasses three dimensions: distributional equity (fair distribution of costs, benefits, burdens, and rights, including equal opportunity for access), procedural equity (inclusive decision-making), and recognitional equity (consideration of stakeholders' knowledge systems, values, and rights). These dimensions are crucial in understanding the impact of these projects on different groups and communities (McDermott et al., 2013).

Other aspects besides socio-demographics are also relevant for UGS usage, e.g., user motivations (e.g., Adeclas et al., 2021; Le Corre et al., 2022), climate and weather conditions (e.g., Liu et al., 2016), UGS characteristics (e.g., Hao & Wang, 2022), or accessibility (e.g., La Rosa et al., 2018).

However, while motivations and climate and weather conditions are not directly linked to equity issues, equitable access to UGS is fundamental for human well-being, with accessibility to UGS being fundamental in assessing UGS provision. The concept of accessibility to UGS within 5 minutes of walking distance for each urban citizen is defended by the EU and by UK Nature, the latter defining a minimum area of 2 ha to be available to urban dwellers within 5 min./300 m. walking distance (Handley et al.,

2003). Studies show that proximity to nature is fundamental for the well-being of urban dwellers (Claris Fisher et al., 2021). However, studies also show that urban dwellers do not choose UGS based exclusively on proximity (e.g., Schindler et al., 2022) and that not all UGS provide the same ES services (Priess et al., 2021). UGS visitors often use more than one ES during a visit as they can engage in different and similar activities, with many interconnected CES-related activities (Plieninger et al., 2013). This is where motivations, climate and weather conditions, and UGS characteristics enter the equation. Assessing and measuring CES preferences can thus be a complex task (Chan et al., 2012), particularly in urban environments (Gómez-Baggethum and Barton, 2012).

Policymakers must understand how access to public green space varies across societies and if its distribution is socially equitable. However, more than understanding the level of access to green spaces is needed (Barbosa et al., 2007). Given the complexity of UGS management (Plieninger et al., 2013), more data-driven methods are needed to support urban planning and smart cities (Engin et al., 2020), which local authorities often lack due to limitations in both human and economic resources, further influenced by specific environmental, cultural and political contexts (Di Marino et al., 2019).

Furthermore, the integration of the GI concept in policy and management fields, along with the integration of the concept of ES, at least in the European context, is affected both by the conflict between new and established concepts and by existing legislation and practice routines (Leone et al., 2023), showing resistance to changes.

Consequently, to better inform policy-making and urban management, a global and deeper understanding is needed regarding both UGS accessibility and well-being benefits derived from UGS use. Several authors highlight the fundamental need to understand the drivers of interactions between urban inhabitants and the surrounding UGS (e.g., Lin et al., 2014). Comparative studies between different countries and cities and studies gathering data via different data collection methods are needed to contribute towards a stronger body of scientific evidence regarding the understanding of human-nature interactions to achieve effective support for the sustainable planning and management of UGS (Priess et al., 2021). Given the previously mentioned resistance to change, many studies and information on the subject are still needed to support a gradual but consistent push for necessary changes.

Adding to the challenges faced by UGS management, traditional top-down planning and design approaches have been proven to have negative implications for environmental justice (e.g., Anguelovski et al., 2018; Kotsila et al., 2021), with a need for a shift towards bottom-up approaches, promoting stakeholder involvement in the planning and decision processes.

However, as far as we can find, studies assessing the contribution of CES in UGS for well-being have focused on assessing limited variables and cannot provide a more holistic overview. There is also a general lack of studies focusing on seasonal variations of UGS usage (Hadwen et al., 2011; Kim et al., 2018; Guan et al., 2021), although climate change can have a profound impact on local usage patterns in the future, influenced by

small changes in seasons and weather patterns (Ahas et al., 2007).

2.2 Management and urban green spaces

While governance, management, and administration are often used interchangeably, they each have distinct roles within an organization. **Governance** is responsible for setting the strategic direction, policies, and principles that guide the organization. It establishes clear objectives, decision-making frameworks, and accountability measures to ensure the organization aligns with its mission and values. **Management**, on the other hand, is focused on the day-to-day operational execution of organizational activities. It involves planning, organizing, directing, and controlling resources to achieve predetermined goals (Chakrabarty, 2001). **Administration**, in contrast, is about the administrative and operational tasks that support the governance and management functions. It includes maintaining records, processing information, and overseeing logistical operations. While these three elements have unique responsibilities, they work together to provide comprehensive oversight and effective implementation within an organization.

Considering the purpose of this thesis, the term' management' will be used throughout the text, as it better reflects the base actions considered in the settled goal and objectives.

Public administration is almost as old as human civilisation (Zian & Khan, 2014). Its theory is rooted in the relationship between theory and scientific research, linked to political science, business administration, and social science (Mordhah, 2020).

Management has evolved, reflecting the evolution of humanity, shifting from nepotism and patronage systems in ancient civilisations (Ferraz, 2009; Guogis et al., 2020) to contemporary bureaucratic functional systems (Ferraz, 2009; Guogis et al., 2020).

Management activities are multifaceted in that they must regulate processes of a diverse nature, such as economic, productive, commercial, financial, ecological and social (Zakarevičius, 2013).

At the beginning of the 21st century, the evolving concerns on how to govern – and not just manage – have increased significantly in diversity and complexity, associated with the ever-increasing size and complexity of current societies (Bryson et al., 2014). Research increasingly realised that a shift was needed towards values such as 'democracy', 'self-respect ', and 'citizen'. New Public Governance (NPG) resulted from this development as a response to the challenges of an increasingly complex, networked and multisectoral world, with responsibilities spread and shared by multiple actors, as well as a response to the shortfall of the previous approaches on public administration, in which both the governments, as well as citizens, businesses, and non-profit organisations, all must have a fundamental role in the solving of public problems (Bryson et al., 2014).

The NPG model greatly emphasised bottom-up approaches and stakeholder inclusion in green urban spaces' design, decision-making, and management processes. Several participatory management theories have gained traction in public management

under the previously mentioned values of democracy and citizenship from NPG.

These inclusive and participatory approaches not only foster a sense of ownership and stewardship among community members but also lead to more sustainable and resilient UGS that reflect the diverse interests and values of the populations they serve (Casprini et al., 2023; Khodaparasti & Garabollagh, 2023).

The management of UGS can be approached at multiple levels, including national, regional, and municipal levels. Each level of government plays a distinct role in the planning, design, maintenance, and governance of green spaces in urban areas.

Municipalities are the main managers of UGS, responsible for the day-to-day operations, maintenance, and programming of parks, gardens, and other green areas (Hansen et al., 2023). Local governments play a vital role in engaging with communities, residents, and stakeholders to ensure that green spaces meet the needs of the local population. Municipalities can tailor management strategies to suit their urban environment's specific characteristics and demands, creating diverse and inclusive green spaces that reflect the community's unique identity.

At the national level, governments can set overall policies, guidelines, and funding priorities for UGS. They can also support research, training, and capacity-building initiatives related to green space management (Hansen et al., 2023).

While each level of government has distinct responsibilities in UGS management, successful outcomes are achieved through collaboration and coordination across different levels and agencies (Leone et al., 2023).

Many European countries have adopted integrated planning approaches that consider green spaces part of a holistic urban ecosystem. Policies and strategies prioritise preserving existing green areas, creating new green infrastructure, and enhancing biodiversity within urban environments (e.g., Hansen et al., 2023; Leone et al., 2023) to increase ES's supply and use.

European cities often emphasise community engagement in the management of UGS. Residents, community groups, and non-profit organisations are actively involved in decision-making processes, maintenance activities, and programming initiatives, fostering a sense of ownership and stewardship among stakeholders (Hansen et al., 2023).

The URBACT programme is a European exchange and learning programme promoting sustainable urban development in different fields (Re-Block Project, 2015). This program has developed a set of processes and tools, promoting a new way of thinking about governance, oriented for co-created and locally implemented sustainable development strategies (https://urbact.eu). This programme has supported over 1,400 partner cities across Europe since its first cycle (2002-2006).

2.3 Limitations regarding the management of urban green spaces

A bibliographic review allowed the identification of extensive research highlighting diverse limitations for the effective management of UGS. The assessed main issues, which are often interlinked, can be resumed into the items identified in Table 1 (for a

detailed description of all the assessed literature on the subject, please see Annex 3).

Local characteristics for the different case study areas were also assessed. Policies regarding urban green space management were considered based on previous work (Leone et al., 2023), involving the participation of stakeholders from both Vilnius and Coimbra, regarding challenges in UGS management. Several issues were highlighted, such as difficulty in establishing communication between different departments, resistance to change, limited human and economic resources, and the lack of effective networks contributing to knowledge sharing, regarding practical information to inform better design and management practices (Leone et al., 2023). These limitations were in line with those identified in a broad literature review (Table 1).

Table 1 – Main limitations regarding the management of UGS

Limitations	**Supporting references**
Lack of funding and resources	Costadone and Vierikko (2023); Randrup et al. (2020)
Conflicting development goals (economic vs. ecologic vs. social)	Costadone and Vierikko (2023)
Competing land use demands	Haland and van den Bosch (2015); Koprowska et al. (2020)
Improper planning and management	Aly and Dimitrijevic (2022); Daniels et al. (2018)
Accessibility and environmental equity issues	Galdino et al. (2022); Rutt and Gulsrud (2016)
Lack of detailed and relevant data to support decision-making	Feltinowski et al. (2018); Ives et al. (2017)
Climate change and environmental impacts	Lindholst et al. (2016)
Maintenance and stewardship	Haland and van den Bosch (2015); Schetke et al. (2016)
Insufficient/non-existent collaboration between institutions	Feltinowski et al. (2018)
Community engagement and participation	Brown and Faferholm (2015); Latinopoulos (2022)
Resistance to change, e.g., shifting from traditional top-down approaches to bottom-up	Ives et a. (2017)

Vilnius is actively promoting green public governance through its participation in several projects under the URBACT programme (e.g., ACCESS, RU: URBAN, Urban Green Labs, Hero, Re-Block) (https://urbact.eu/lietuva). The city is also implementing the Green Wave initiative for the planting of 100,000 trees, 10 million shrubs and 300,000 vines and is also part of the European Green City Accord[1]. All these initiatives promote community participation in managing UGS in Vilnius, fostering a sense of community cohesion and civic pride.

1 https://environment.ec.europa.eu/news/green-city-accord-focus-vilnius-2022-12-07_en

The renewal project of the Reformatų Garden in Pylimo Street was part of the Green City Accord, aiming to protect and enhance local biodiversity. The Šnipiškiai square project, recently finished in Kintų Street, was developed considering local community suggestions[2].

The Žirmūnai Triangle Local Action Plan (LAP) is also an example of green collaborative governance in Vilnius. The project was developed under the European URBACT programme, within the Re-Block project, and involved local administration (Vilnius Municipality), the private sector (via the enterprise PUPA – Public Urbanism Personal Architecture), and local stakeholders, including the local population (Re-Block Project, 2015).

Vilnius has also been implementing Nature-based Solutions (NbS). NbS refers to interventions that integrate natural elements into urban planning to enhance the quality of the urban environment by mimicking natural processes (Pinto et al., 2023a). NbS are fundamental to improving environmental and social well-being (Cohen-Shacham et al., 2016).

Oporto and Coimbra have also been active under the URBACT programme. For example, Oporto is linked to projects SmartImpact, Innovato-R, In Focus, Jessica 4 Cities, and ENTER.HUB. Coimbra is linked to projects FOOD CORRIDORS, FEMACT-Cities, and Gen-Y City[3].

Other local projects have also been developed using various approaches, e.g., co-production and NbS integration. The Parque da Cidade (City Park) in Oporto (assessed in Study 8) included integrating several NbS ideas, mainly focused on water retention and infiltration.

In Coimbra, Mondego Green Park (Study 4) was designed as a NbS to control river floods, with lower areas working as buffer zones. Although older UGSs were mainly designed using a traditional top-down approach, newer UGSs, such as the Vale das Flores Linear Park (Study 4), included the consultation of local inhabitants in the design process.

Overall, managing UGS in European countries, including Lithuania and Portugal, reflects a commitment to sustainability, innovation, and community engagement. This ensures the continued development of resilient urban environments that benefit people and nature by supplying ES and well-being benefits. Hansen et al. (2023) identified a positive advancement between 2014 and 2021 in eleven European cities regarding policy and management tools focused on ecological issues such as climate adaptation and biodiversity support, as well as a shift towards co-governance processes.

However, the authors also verified that vertical integration was not always working, with several cases where national and local levels were misaligned. Furthermore, these innovations face challenges such as silos and organisational routines (Hansen et al., 2023; Kauark-Fontes et al., 2023), with difficulties in inter-departmental

2 https://madeinvilnius.lt/en/news/city/how-many-new-park-open-spaces-or-squares-are-planned-to-be-built-in-Vilnius/

3 https://urbact.eu/portugal

communication and collaboration (Hansen et al., 2023; Leone et al., 2023). Often, adopting new approaches depends on the staff's interest in exploring new concepts (Leone et al., 2023). Additionally, even with the awareness that relevant changes are needed, municipalities and their representatives often need more means to enforce them (Hansen et al., 2023).

Adopting measures such as NbS is an example of the difficulties in departmental collaboration. Social justice problems have also been associated with UGS investments, particularly gentrification issues when most vulnerable groups are forced to move from areas where new or improved UGS contribute to prohibitive increases in house rents and prices (Van Der Jagt et al., 2019). This highlights that investments in UGS can bring complex and negative social impacts (Kronenberg et al., 2021). Casprini et al. (2023) stated that although green governance is a common and progressive trend in many European cities, it is sometimes associated with negative societal outcomes regarding distributional justice.

Hansen et al. (2023) stressed that several challenges remain for a broader and more effective implementation of green space planning and governance. These include tackling long-term maintenance challenges, obtaining adequate funding, and encouraging a change in organisational culture towards collaborative governance.

2.3.1 The critical role of field data in supporting UGS management

The evolution of public management theory has greatly influenced the management of public green spaces in urban areas. From the early principles of scientific management to the modern approaches of NPG, theories have guided the development of strategies and practices to manage these valuable resources effectively.

In recent years, there has been a growing recognition of the importance of data-driven decision-making in managing public UGS (Rambhia et al., 2024). Using Geographic Information Systems (GIS), remote sensing technologies, and citizen science initiatives has enabled managers to collect real-time data on vegetation health, visitor patterns, and ecosystem services provided by green spaces.

Studies measuring air quality, biodiversity, and social interactions in UGS have provided valuable insights into their benefits and challenges. Research such as the work of Kaplan and Kaplan (1989) and Kaplan (1995) on the therapeutic benefits of nature or the study by Dallimer et al. (2012) on the biodiversity value of UGS for human well-being has informed decision-making processes and shaped management practices in these areas.

Reliable field data is essential to support evidence-based decision-making focused on management and maintenance priorities, oriented towards the sustainable management of UGS (Hansen et al., 2023; Moller et al., 2019). This has been particularly relevant in bottom-up approaches, where citizens can have an active voice.

At the municipal level, there is a critical need for multi-dimensional data to support adequate evidence-based decisions (WHO, 2017). This is needed to balance social, environmental, and economic objectives (Rambhia et al., 2024) while ensuring

the maximisation of the provision of ES. Multiple sources of data and collection methods are beneficial at this level, given its frequent limitation in both economic and human resources (De Luca et al., 2021; Hansen et al., 2023; Khodaparasti and Garaballagh, 2023; Van Der Jagt et al., 2020). Plitt et al. (2021) reported that 72% of assessed organisations in 12 cities in the USA reported a staff shortage for the management of green areas, while 82% reported an increase in visitation numbers. Furthermore, 83% of them showed budgetary concerns.

2.3.2 Financial support for UGS management

Several European funds are currently open for the period 2022-2027, which can support a variety of projects (Table 2).

EU new policy objective "Europe closer to citizens" (PO5) provides for a stronger urban and territorial dimension, supporting a bottom-up place-based approach. The EU defined an initial target of 8% of its European Regional Development Fund (ERDF) for sustainable urban development support at both national and regional level. For the 2021-2027 programming period, the average value for all Member States was 12% (Onaca et al., 2023), indicating a strong will to invest towards sustainability.

Table 2 – European Union funding programs

Fund	Notes	Accessibility	UGS development
EIT Climate-KIC	Funding for projects related to climate change adaptation and mitigation, including green infrastructure initiatives.		x
European Investment Bank (EIB)	Offers financing and expertise for sustainable urban development projects, including green infrastructure and climate adaptation initiatives. It also offers financing for projects that enhance infrastructure, including accessibility improvements in urban areas.	x	x
European Regional Development Fund (ERDF)	Supports sustainable urban development projects, including those focusing on accessibility, sustainable development, climate change adaptation, green infrastructure and environmental improvements, and public spaces.	x	x
European Research Council (ERC)	Supports scientific research projects.	x	x

European Social Fund (ESF+)	Funds initiatives that promote social inclusion and improve the quality of life, potentially supporting projects enhancing UGS and accessibility improvements in urban areas.	x	x
European Structural and Investment Funds (ESIF)	Funds aimed at reducing regional disparities and promoting sustainable development, which could include projects related to urban greening and climate resilience.		x
Horizon Europe	Provides funding for research and innovation projects, including those related to nature-based solutions, urban sustainability, and climate adaptation initiatives.	x	x
LIFE Programme	Provides funding for projects that contribute to environmental and climate objectives, supporting projects related to nature conservation and biodiversity, climate change adaptation, green infrastructure initiatives in urban areas, and the development of UGS.		x
Urban Innovative Actions (UIA)	Supports innovative projects in urban areas, including those addressing climate change adaptation and green infrastructure development.		x

There are also funding opportunities at the national level. For Lithuania, two funding sources were identified: the Lithuanian Environmental Investment Fund and the Lithuanian Environmental Protection Agency (EPA).

For the Portuguese case, four sources can be mentioned: the Portuguese Environmental Fund, the Portuguese National Environmental Fund, the Portuguese Environment Agency (APA) and the Ministry of Environment and Climate Action.

As for the application in other European contexts, the analysis on funding opportunities should extend to the funding tools available at national level in each country.

3. METHODS

3.1 Case studies

The assessed case studies include Vilnius in Lithuania and Coimbra and Oporto in Portugal (Figure 1). First and foremost, the selection of case studies was conditioned by the geographical constraints of the doctoral scholarship supporting these studies (FCT international PhD scholarship, with hosting institutions in Portugal and Lithuania).

Besides this constraint, the selection was based on the goal and objectives identified for the thesis. To test data collection models and maximize the identification of relevant variables affecting preferences for using UGS, instead of comparing equivalent cities, it was opted to assess different realities, considering diversity in geographical, climatic, cultural, urban, and social characteristics.

The selected cities are intended to represent geographical and climatic contrasts inside European limits, with Vilnius in the north-eastern limit of Europe and Coimbra and Porto in the south-eastern limit. They also represent diversity in urban development, population size and density, and UGS availability (Table 3).

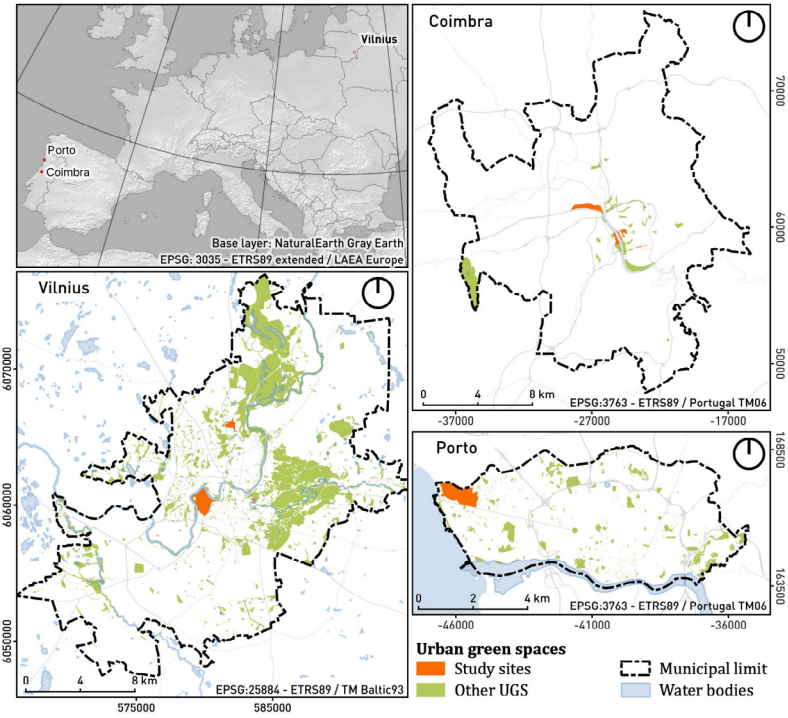

Figure 1 – Location of the case studies.

Vilnius, the capital of Lithuania, is in north-eastern Europe. It has a population of 588,412 inhabitants (SECR, 2021) and a population density of 1,337 inhab./km^2. It is in the valley of the Neris River and is considered one of the greenest capitals in Europe. Terrain roughness is low, with the presence of many lakes. Its urban structure includes many recreational UGS areas evenly spread inside the municipal territory, covering an area of 73.52 km^2 (18.3% of the municipal territory), representing 124.95 m^2 of UGS per capita. This value is in line with the European average (Xu et al., 2022). According to the Köppen-Geiger classification, Vilnius's climate is continental (Köppen-Geiger: Dfb), with a cold climate, no dry seasons, and warm summers (Beck et al., 2018). The winter season usually allows for engaging in winter sports such as skiing.

Porto is Portugal's second-largest city, with 230,992 inhabitants (INE, 2022). The city registers a Mediterranean climate (Csb), with a temperate climate and dry and warm summers (Beck et al., 2018). Winter days are often sunny, allowing for visits to UGS. The city's urban fabric is compact and dense, with a population density of 5,577 inhab./km^2. The city UGS covers 5.08 km^2 (12.4% of the city), corresponding to 22.00 m^2 of UGS per capita. Porto includes the largest urban park in Portugal ("Parque da Cidade", with 73.59 ha), bordering the Atlantic Ocean, a rare feature worldwide.

Coimbra is the largest city in the central region of Portugal. It has a population of 106,580 inhabitants (1,281 inhab./km^2) (INE, 2022). The old town grew on top of a steep hill near the margins of the Mondego River and is characterised by a mixture of low terrain roughness in the vicinity of the river and a high level of roughness in the consolidated urban area. Its few available recreational UGS are in the core city area, close to the river, covering 6.55 km^2 (12.8% of the municipal area), representing 46.52 m^2 of UGS per capita. Its climate is Mediterranean (Köppen-Geiger: Csb) (Beck et al., 2018), the same as Porto.

According to the OECD (2024), Vilnius is considered a metropolitan area (population between 500,000 and 1 .5 billion), Porto is a medium-size urban area (population between 200,000 and 500,000), and Coimbra is a small urban area (population between 50,000 and 200,000). The Portuguese cities show a smaller percentage of urban green space (12.4% for Porto and 12.8% for Coimbra) when compared to Vilnius, which is in line with the European average (18%) (Xu et al., 2022). The differences in green space per capita are also very clear, with Porto offering the lowest green space per capita (Table 1), followed by Coimbra. Vilnius offers almost 6 times more green space per capita than Porto. When comparing changes in green space over time, Lithuanian cities registered a progressive growth in the period 1990-2015, while Portuguese cities showed a relevant growth for the 2000-2015 period (Xu et al., 2022).

Table 3 – Case study main characteristics

City	National administrative structure	Climate	City area (km²)	Public green space* (km²)	Green space per capita (m²)	Population 2021 census, (pop. density per km²), and urban area class**
Vilnius (Lithuania)	Unitary semi-presidential republic, with counties, divided into municipalities	Continental (Dfb)	401	73.52	124.95	588,412 (1,337) (metropolitan area)
Porto (Portugal)	Unitary semi-presidential republic, with districts (regions) divided into municipalities	Mediterranean (Csb)	41	5.08	22.00	230,992 (5,577) (medium size urban area)
Coimbra (Portugal)		Mediterranean (Csb)	51	6.55	46.52	106,580 (1,281) (small urban area)

* Formal green space for recreation with public access.

** City size class by urban population according to OECD, 2024.

3.1.1 Background of EU funding for sustainable development

As pointed out in section 2.3.2 (Financial support for UGS management), different European funds can support environmental-related projects. Based on the data from the 2021-2027 programming period regarding funds oriented towards the promotion of sustainable development, from the EU-27 member states considered, Portugal showed the highest percentage of EU funds oriented for sustainable development (25%) related to the total amount of EU funds for the country, with Lithuania showing in 3rd position (16%) (Onaca et al., 2023). Both countries are above the European average (12%).

The EU funds for the promotion of sustainable development for the 2021-2027 period amounts to a total of 28 billion Euro (Table 4) (Onaca et al., 2023). This multiple fund program allows for multi-thematic support for integrated territorial development. The distribution by funding program, and the amount of funds for both Portugal and Lithuanian is listed in Table 4, by territorial instruments.

According to the assessed data, Portugal focused mainly on the European Regional Development Fund (ERDF), and mostly on territorial instruments at the level of the Functional Urban Areas (FUA). It also includes a small amount related to national developed funds ('Other Territorial Tools' – OTT) for urban neighbourhoods. Lithuania, on the other side, shows a diversified set of funding sources, particularly relying on the Cohesion Fund (CF), followed by the European Social Fund (ESF+), and the ERDF.

Regarding territorial instruments, the most relevant is the Cities, towns and suburbs level, for both the CF and the ESF+, under the Integrated Territorial Instruments (ITI). But a large amount of the funding, from the ESF+, is also linked to the Community Led Local Development (CLLD) territorial instrument, which is specifically intended to involve local stakeholders.

Regarding the overall European funding according to the different policy objectives defined by the EU, Policy Objective 5 (PO5) – Europe Closer to Citizens (12.6B€) and PO2 – Greener Europe (10.5B€), have the highest contribution towards sustainable urban development, with PO4 – Social Europe coming in a distant third place (3.1B€). Portugal and Lithuania follow a similar trend, although the distribution for Lithuania is more even.

Table 4 – EU funding sources for the promotion of sustainable development for the 2021-2027 period. Programs and territorial instruments under each program for Portugal and Lithuania (source: Onaca et al., 2023).

Program	Amount	Portugal	Lithuania
European Regional Development Fund (ERDF)	24,436,568,300€	3rd	8th
03 ITI – Functional urban areas		2,758,888,236€	1,560,000€
02. ITI – Cities, towns and suburbs		72,555,000€	-
17. OTT – Urban neighbourhoods		6,880,894€	-
European Social Fund (ESF+)	1,787,212,031€	3rd	8th
03 ITI – Functional urban areas		226,174,000€	-
10 CLLD – Cities, towns and suburbs		-	23,243,497€
02. ITI – Cities, towns and suburbs		-	5,766,343€
Cohesion Fund (CF)	1,275,035,282€	-	3rd
02. ITI – Cities, towns and suburbs		-	59,000,000€
Just Transition Fund (JTF)	770,150,536€	-	-
Interreg	17,879,767€	-	-
Overall	28,293,845,885€	3rd	13th

Territorial instruments:
ITI – Integrated Territorial Instruments
CLLD – Community Led Local Development
OTT – Other Territorial Tools (nationally developed tools)
Greyed out lines correspond to funds not used by both countries.

When comparing the attributed funds by specific objectives, the investment priority for sustainable urban development for the 2021-2027 period will take place under the Specific Objective 5.1 (SO5.1) – Integrated development of urban areas, both at the EU-27 level, as well as for Portugal and Lithuania (Table 5) (Onaca et al., 2023). The second most relevant objective, at both the EU-27 and Lithuania level, is SO2.8 - sustainable urban mobility.

Table 5 – Specific objectives and rank of investment (EU-27 average, Portugal, and Lithuania)
(source: Onaca et al., 2023).

Specific objectives	EU-27	Portugal	Lithuania
SO5.1 Integrated development in urban areas	1	1	1
SO2.8 Sustainable urban mobility	2	6	2
SO2.1 Energy efficiency	3	4	-
SO2.7 Nature protection and biodiversity	4	8	6
SO8.1 Just Transition Fund	5	-	-
SO4.11 Equal access to quality social and healthcare services	6	9	10
SO2.4 Climate change adaptation	7	7	-
SO2.5 Sustainable water	8	2	-
SO4.2 Education and training infrastructure	9	-	7
SO1.2 Reaping the benefits of digitisation	10	10	-
SO4.3 Integration of marginalised communities	…	-	3
SO1.3 Growth and competitiveness of SMEs	…	3	-
SO4.5 Access to health care	…	-	4
SO4.8 Active inclusion and employability	…	-	5
SO2.6 Circular economy	...	5	9
SO3.2 Sustainable transport	...	-	8
SO4.1 Access to employment and activation measures for all	…	11	-

Investment priorities suggest that Lithuania is particularly focused on social equity, with its top-10 priorities including equal access to quality social and healthcare services (SO4.11), education and training infrastructure (SO4.2), integration of marginalised communities (SO4.3), access to health care (SO4.5), active inclusion and employability (SO4.8), and circular economy (SO2.6).

Portugal, on the other hand, is particularly focused on issues related to climate change adaptation (SO2.7), energy efficiency (SO2.1), and sustainable water (SO2.4),

PO5 specific objective 1 (SO5.1) is focused on *'Fostering the integrated and inclusive social, economic, and environment development, culture, natural heritage, sustainable tourism*. Regarding the specific intervention fields under SO5.1, its resources primarily fund the physical regeneration of public spaces, protection of cultural heritage, improvement of cultural services and tourism assets, territorial development initiatives, and promotion of natural heritage and eco-tourism, with a focus on urban regeneration supported by public investment (Table 6). While Portugal showed a distribution of investments by intervention fields similar to the EU-27 average, Lithuania exclusively focused on investments related to territorial development initiatives – preparation (intervention field 169).

Table 6 – Intervention fields under SO5.1 and rank of investment (EU-27 average, Portugal, and Lithuania) (source: Onaca et al., 2023).

Intervention fields under SO5.1	EU-27	Portugal	Lithuania
168 Physical regeneration and security of public spaces	1	1	-
166 Cultural heritage and cultural services	2	2	-
165 Public tourism assets and related tourism services	3	3	-
169 Territorial development initiatives - preparation	4	5	1
167 Natural heritage and eco-tourism other than Natura 2000	5	4	-

3.2 Working methodology

Figure 2 shows the flowchart for the working methodology. The research work started with a review of different UGBI typologies and assessing their relevance for the provision of ES (study 2). UGS were confirmed as the most relevant UGBI for the provision of ES, particularly regarding CES. The next step was a review on the limitations of UGS management (Annex 3), identifying data availability as one of the key factors for effective UGS management.

This step was followed by a review of data-collection methods related to preferences for UGS and associated ES and two other reviews on variables related to UGS preferences (literature review) and UGS contribution to ES and well-being (systematic review) (study 1). These reviews were the basis for the selection of a set of data collection methods and for the definition of a set of variables to assess through practical work. Based on the previous steps, a set of studies was organized and implemented to assess the practical use of the selected data collection methods and variables, identify possible factors affecting UGS preferences, and identify relevant social and environmental issues that could be relevant under a management framework (studies 3, 4, 6, 7, and 8). During this process, a specific method for collecting field data based on observations was developed (study 5). The results from the previous steps provided the information for defining the data-based framework. The data collection methods, as well as the relevant variables and resulting factors, fed the data collection module, the backbone of the framework. The other results provided relevant insights into key social and environmental issues to be considered in identifying and designing the framework's different action modules. Practical management-related ideas also emerged from the previous step, providing complementary inputs to defining action modules and associated actions.

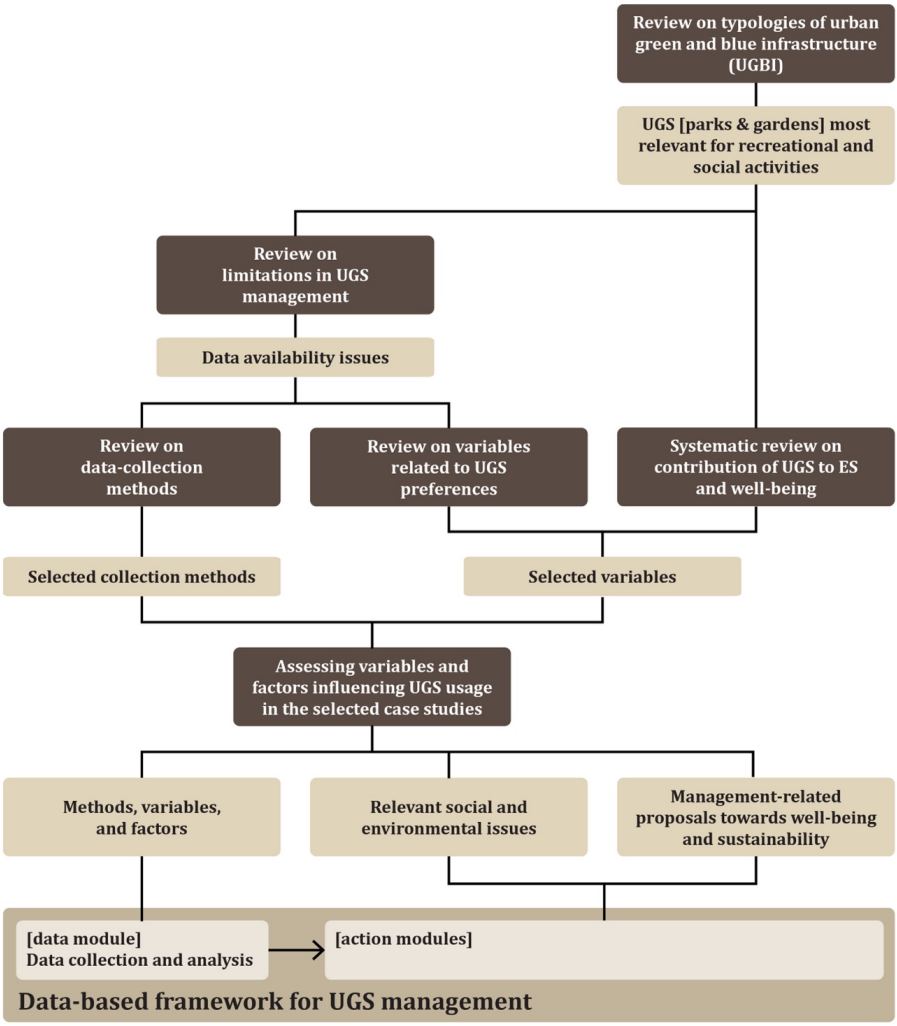

Figure 2 – Research scheme.

3.3 Methods of the studies

As previously stated, eight articles were written in the context of this dissertation. This subsection shows a resume of the methods per article. A systematic review was developed to assess the current situation regarding scientific research related to the assessment of the contribution of UGS to ES and human well-being. A further evaluation was made on the main types of UGBI, their integration with NbS, and their contribution towards UNs' SDGs and contributions towards well-being, also assessing

environmental justice-related issues. The main variables and factors influencing UGS use and CES-related activities were assessed in three contrasting European cities in terms of climate and demographic characteristics. These variables included socio-demographic variables, user motivations and perceptions on preferences for UGS use, related CES and well-being benefits, UGS characteristics, time-related variables, such as season and time of the day, and accessibility characteristics. These assessments were done with different methods. A semi-qualitative face-to-face survey was used in Study 4. A PPGIS survey was applied in study 6. A qualitative observation-based survey was applied on-site for study 7. This last study applied a methodology to optimise data collection through observation-based fieldwork (study 5). Study 3, on accessibility issues, used GIS-based quantitative methods, namely network analysis assessment for different travel modes. Study 8 assessed the relevance of landscape elements in user preferences for CES-related activities on different landscape units through a qualitative face-to-face survey.

Study 1: Ecosystem services and wellbeing dimensions related to urban Green spaces – A Systematic Review (2022)

Review type. Systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) framework (Koutsos et al., 2019).

Eligibility criteria. All articles published in peer-reviewed scholarly journals after 2000 (up to April 2021) addressing the contribution of UGS to the provision of ES and human well-being.

Search strategy. The search was conducted in both primary and secondary sources, according to Gusenbauer and Haddaway (2020). Primary sources included the following databases: BASE (1,064 articles selected), EbscoHost (165), Ovid (752), PubMed (9), ScienceDirect (1,003), Scopus (29), Web of Science (21), Wiley (52). Secondary sources included DOAJ (4), JSTOR (135), Springer (170), and B-On (223). The search keywords were: *'urban green spaces'*, *'ecosystem services'*, *'wellbeing'*, *'evaluating'*, *'benefits'*, *'methodologies'*, *and 'methods'*. The search identified a total of 3,626 potential articles. This number included 12 articles found by snowballing while reading the selected articles in the second stage of the selection process.

Quality assessment and inclusion criteria. Inclusion criteria considered articles published in English and peer-reviewed articles only. Exclusion criteria comprised the rejection of review articles, articles not mentioning UGS, articles without explicit identification of the methods used, articles not allowing for the identification of the well-being types and respective benefits, articles not allowing the identification of UGS type(s) considered, and articles not allowing for the identification of ES assessed, according to the CICES v5.1 framework. A total of 218 articles fulfilled the inclusion criteria and passed through the exclusion process.

Coding of studies. Articles were classified regarding geographic coverage (city, country, world region, continent), UGS type (aggregated in classes and subclasses), ES classes (according to CICES v5.1 classification, by Haines-Young and Potschin, 2018), assessed well-being dimensions (Freedom of choice and action, Health – mental and physical, Good social relations, Food security, and Physical security, based on the

well-being dimensions identified on CICES v4.3, by Haines-Young, 2013), and assessment methods used (indicators, models, mixed, and surveys; surveys were subdivided into normal survey, PPGIS survey, survey + biofeedback, survey + environmental sensors, surveys + indicators, surveys + statistical model, survey + WTP/CVM).

Study 2: Green and Blue Infrastructure (GBI) and Urban Nature-based Solutions (NbS) Contribution to human and ecological wellbeing and health (2023)

Review type. Literature review.

Eligibility criteria: Articles published in peer-reviewed scholarly journals addressing different aspects of GBI and NbS's contribution to human and ecological well-being in urban areas.

Search strategy. Articles were selected by searching Scopus and ScienceDirect online services, using keywords *'urban green and blue infrastructure'*, *'nature-based solutions'*, *'ecosystem services'*, and *'wellbeing'*.

Procedure. Literature was assessed to identify as many relevant UGBI classes as possible, briefly characterising them, including the most pertinent ES supplied and potential contributions to UNs' SDGs. We further identified examples of NbS, associated UGBI classes, and related contributions to the different well-being dimensions.

Study 3: Urban green spaces accessibility in two European cities: Vilnius (Lithuania) and Coimbra (Portugal) (2022)

Spatial coverage. We assessed accessibility to UGS in two distinct European cities: Coimbra, in Portugal, and Vilnius, in Lithuania.

Methods. We developed a quantitative analysis of UGS accessibility based on the Iso-area algorithm in QGIS, a Geographical Information System (GIS) software. The Iso-area algorithm calculates areas whose limits represent a travel-time interval, similar to the concept of contour, or elevation lines, but applied to travel-time values. We calculated 5- and 10-minute travel time distances for four different transport modes – by foot, bike, bus, and car –and examined their area and population coverage. We considered a set of network restrictions according to transport mode, including access restrictions (e.g., no use of stairs for cyclists or motorised vehicles, exclusive use of bus routes for public transport, and road direction restrictions for all motorised vehicles) and average speeds (e.g., 3.6km/h for pedestrians, 15km/h for cyclists, 16.8km/h for buses in Coimbra and 22.8km/h in Vilnius, and an average speed of 23.0km/h for cars inside urban limits).

Study 4: Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal) (2021)

Sample characteristics. A total of 1000 UGS visitors were interviewed, 200 per assessed UGS, in Coimbra, Portugal. The sample comprised 50.6% female respondents and 49.4% male respondents. The dominant age group was 26-45 (35.4%). Most users arrived by car (45.9%), followed by walking (41.3%). Weekly visits dominated (46.5%).

Variables. We collected data regarding socio-demographic variables sex, age group, education level, income level, transport type, distance to home, frequency of visit, most frequent activities (up to 3), overall relevance of primary activity, relevance of main activity for three well-being dimensions (physical, mental, and social),

motivations for main activity, and perceived disservices.

Methods. We applied a semi-qualitative survey. A mobile app was developed with the AppSheet service (www.appsheet.com) to support on-site data collection, ensuring fast data collection while avoiding missing data. Collected data was analysed through descriptive statistics and exploratory factor analysis (EFA) to identify the main factors influencing user preferences. Spatial analyses were done to assess travel distances. Kernel density estimation heatmaps and standard deviation ellipses were calculated to assess influence areas for each park.

Procedure. Participants were randomly approached inside the UGS and asked to answer a questionnaire on the three most common activities performed in the visited UGS and their perceived benefits for well-being. The answer time varied from 10 to 45 minutes, depending on the participant's willingness to provide feedback on the assessed topic.

Study 5: Factors affecting cultural ecosystem services use in Vilnius (Lithuania): A participatory mapping survey approach (2023)

Sample characteristics. A total of 1,576 responses were collected from Vilnius inhabitants. Respondents were representative of the Vilnius population. The sample included 50.1% female respondents and 49.3% male respondents. The dominant age group was 25-64 (69.7%). Most users were willing to travel 10 km or more to engage in CES-related activities in Vilnius (37.3%). Monthly visits dominated (36.1%), and physical and social activities showed the highest relevance among users (66.8% and 67.9%, respectively, considering them relevant and highly relevant).

Variables. We collected data regarding socio-demographic variables such as sex, age group, education level, transport type, distance willing to travel, and frequency of visit. Data was also collected on preferred locations for 5 different groups of CES-related activities (Social, Inspirational, Cultural, Spiritual, and Physical activities) and the relevance of a selection of motivations for each activity group (derived from the Recreation Experience Preference scales by Driver, 1983). Motivations were ranked using a 5-point Likert scale (1 – very unimportant to 5 – very important).

Methods. A PPGIS online survey was built with the ESRI Survey 123 platform for ArcGIS (ESRI, 2021). The collected data was analysed through descriptive statistics and EFA to identify the main factors influencing user preferences for the different groups of activities. Kernel density estimation heatmaps and standard deviation ellipses were calculated to assess influence areas for each group of activities.

Procedure. The survey was conducted by a specialised survey company, which distributed the online survey to a random selection of respondents based on probability sampling to ensure statistical representation of the Vilnius population by age, gender, and eldership distribution.

Study 6: Observation-based data-gathering method to support the assessment of the use of cultural ecosystem services in urban green spaces (2023)

Materials. The developed data-gathering method includes three stages: preparation, experimental, and survey. The method is based on a mobile app, developed with the AppSheet service (www.appsheet.com), optimised to allow for fast and accurate

data collection, including compiling information on CES-related activities, socio-demographic and seasonal data, and UGS spatial characteristics.

Fieldwork guidelines. Several guidelines were defined for the implementation of efficient and valid fieldwork. These guidelines include, e.g., the necessity to define the spatial coverage of the UGS under analysis to ensure adequate and even coverage; the definition of a work calendar to ensure even coverage of the defined data frame; time-related guidelines, focusing on timeslot definition and coverage; participation of multiple observers; survey experimental stage; preparation for observations; specific coding conventions, including specific rules for situations which can be more subjective, e.g., when registering an activity of a group of users including children, the preference for the activity to register is always '*activities with children*'.

Optimisation measures. To ensure easy and fast data collection, optimisation measures were defined and implemented in the app, including selection-dependent sub-menus, e.g., when selecting the option 'stationary user(s)' for a new observation, the list of activities to choose from is restricted to predefined stationary activities; when collecting an observation for a moving user, the 'solar exposure' option is hidden; when collecting an observation of a single individual, the 'mixed' option is hidden in the 'sex' field.

Study 7: Temporal and spatial differences in human activities performed in Urban Green Spaces of Vilnius (Lithuania) (2024)

Sample characteristics. 19,992 observations were collected in three UGS in Vilnius, Lithuania, distributed in two different seasons: Winter (7,255) and Summer (12,737). These observations corresponded to 40,317 users (11,926 in Winter and 28,391 in Summer). Female users dominated observations (40.8% of all observations, both for individual users or groups), followed by male users (30.5%), The other 27.9% of observations corresponded to groups with both female and male users. Young adults and adults dominated the observations (76.4%), followed by seniors (17.6%). Groups with mixed ages corresponded to 2.6%.

Variables. Collected variables included location coordinates, date, time, park, day of the week, week period, timeslot, user type, with or without children, number of users per observation, sex, age group, motion status, activity performed/observed, cloud coverage, wind speed, precipitation, air temperature, solar exposure, and snow in the ground.

Methods. A qualitative survey was applied. The mobile app developed in Study 6 was used as a data-collecting tool. The collected data was statistically analysed. A Spearman correlation was used to assess relations between weather data and observed activities. An EFA was performed to identify the main factors influencing user activities. Spatial analyses assessed the distribution of all registered activities by control variables (*Season*, *Week period*, and *Timeslot*). These analyses included Kernel density estimation heatmaps and standard deviation ellipses. A Global Moran's I spatial autocorrelation was used to assess possible relations between park features and different activity groups.

Procedure. During the summer (July 2021) and winter (January and February

2022) seasons, we surveyed the different parks for a whole week, including both workdays and weekend days, from 8h00 to 20h00 (8h00 to 17h30 in winter). We walked along the selected paths during this period, registering as many observations as possible. In crowded areas, registration was done for at least 5 minutes to ensure an adequate number of observations. Repeated users were only registered again, in the same timeslot, if they were observed doing a different activity than the one previously recorded.

Study 8: Relevant landscape components in an ample urban green space in Oporto (Portugal) (2024)

Sample characteristics. 500 surveys were collected, corresponding to 50 stationary users in each of the 10 landscape units identified in the study area. Female users corresponded to 50.2% of the total responders. The dominant age group corresponded to ages 26-45 (43.6%), with most users having higher education (49.6%). The visit frequency was monthly primarily (44.6%), with most users (68.6%) attributing a high relevance to the activity performed.

Variables. The collected variables included sex, age group, education level, frequency of visit, activity performed, relevance of activity, and perceived relevance of a set of landscape components for the engaged activity in the selected landscape unit, namely the relevance of: *'open space for activities'*, *'recreational facilities'*, *'cultural equipment'*, *'sport equipment'*, *'shadow areas'*, *'vegetation density'*, *'good maintenance of the park'*, *'tranquillity of the space'*, *'diversity of open and closed spaces'*, *'diversity of flora and fauna', 'presence of a water element'*, *'forest coverage'*, and *'presence of shrubs'*.

Methods. A qualitative survey was implemented, and a mobile app was developed to support data collection in the field. The collected data was analysed for significant differences between landscape units for socio-demographic variables and landscape components' preferences. An EFA was applied to identify relevant groups of park elements influencing usage preferences. A spatial analysis was done by mapping the EFA scores to assess their relevance regarding the different landscape units.

Procedure. The survey was developed during the summer of 2022 (July and August), including both workdays and weekend days. We walked along the different areas of the park, randomly addressing stationary users involved in diverse activities. We identified ourselves, explained the background and objectives of our survey, and asked if they were willing to participate. We repeated the process until we collected 50 interviews in each landscape unit.

4. SUMMARY OF THE RESULTS

Overview of Study 1. Most studies on ecosystem services and well-being dimensions of UGS were conducted in Europe, China, the United States of America (USA), and South Africa (Figure 3). Among all UGS classes, *parks and gardens* were the most studied. *Urban trees*, *forests*, *coastal mangroves*, *golf courses*, *roadside vegetation*, and *brownfields/unmanaged urban greenery* were the least addressed UGS types. Cultural ES were the most studied ES. *Health (mental and physical)* and *good social relations* were the most investigated dimensions of well-being, and *food security* received the least attention. Surveys, indicators, and surveys combined with statistical methods were the most common methodologies. From the studies providing spatial modelling, only a tiny number were validated.

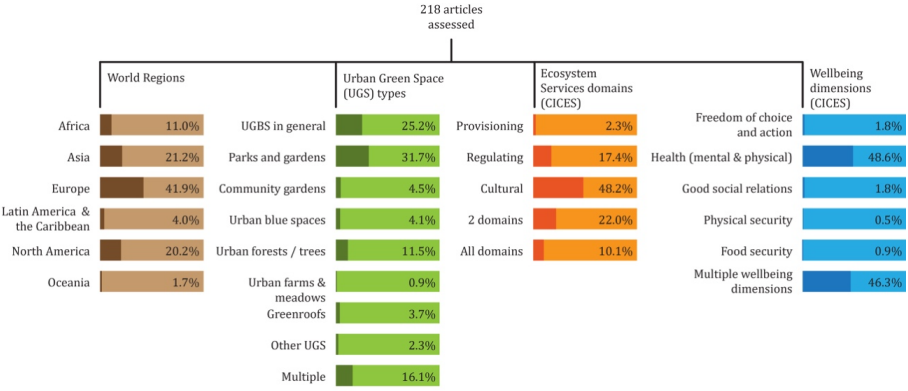

Figure 3– Visual resume of study 1 results (based on Pinto et al., 2022b).

Overview of study 2. This study identified a non-exhaustive list of 28 UGBI types and the most common ES provided based on the CICES v5.1 classification (Haines-Young & Potschin, 2018) (Figure 4). We also identified examples of NbS actions (15 examples), integrating different combinations of UGBI types. We further identified the main well-being benefits associated with the different UGBI types and NbS actions. The well-being benefits were assessed considering a set of well-being dimensions derived from the CICES v4.3 documentation (Haines-Young, 2013), namely: (a) freedom of choice and action, (b) health (mental and physical), (c) Good social relations, (d) food security, and (e) physical security. Most UGBI and NbS positively contribute to most of the UNs' SDGs (e.g., SDGs 1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14, and 15). Environmental justice issues were identified as potential problems arising from developing new UGBI and NbS projects under a traditional top-down approach. We identified the need for stakeholder involvement in the effective development of UGBI and NbS projects to ensure success in preserving natural ecosystems, enhancing their resilience to climate change, and contributing to environmental justice.

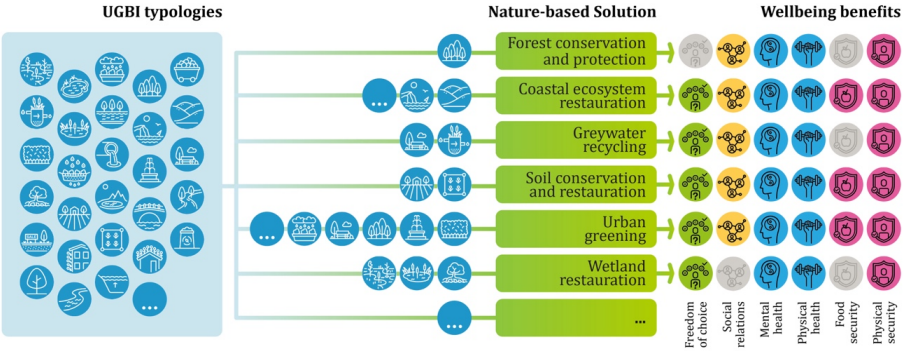

Figure 4 – Visual resume of study 2 results (based on: 2023a).

Overview of study 3. The study found relevant differences between the two assessed cities (Vilnius and Coimbra) in terms of both the number and spatial distribution of UGS and their accessibility. Vilnius registers more recreational UGS and road network density, cycleways and footways density, and bus lines than Coimbra (Figure 5). Vilnius showed higher accessibility to recreational UGS than Coimbra in all transport modes. In both cities, the accessibility was highest by car, closely followed by access by bicycle, and lowest by bus and by foot. The population covered by 5- and 10-minute distance UGS accessibility in Vilnius is higher than in Coimbra despite the lower population density in Vilnius.

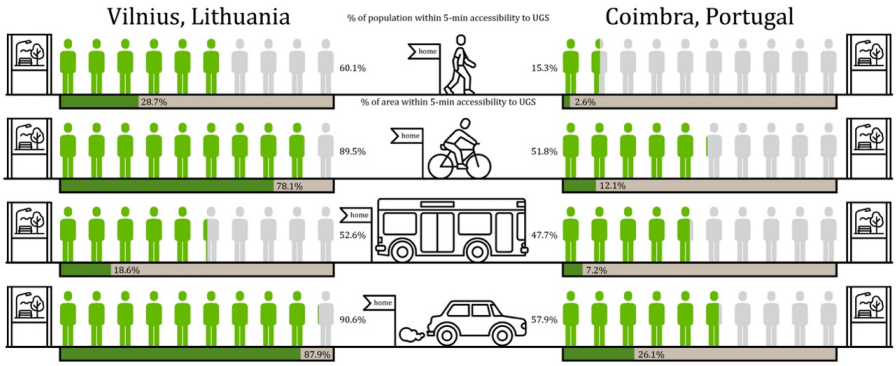

Figure 5 – Visual resume of study 3 results (source: Pinto et al., 2022a).

Overview of study 4. Walking (35.7%), meeting people (15.5%), practising sports (7.5%) and doing activities with children (7.5%) were the most frequent activities in the assessed parks in Coimbra. The users perceive these activities as beneficial for physical and emotional well-being. Multifunctionality is a characteristic of all parks and is highly appreciated by the users. There are significant differences between parks regarding socio-demographic characteristics of the users and motivations. The tranquillity of space and landscape beauty are the primary motivations for using Manuel

Braga Park and the Botanical Garden. Distance to the park and transportation are significant for visitors to the Botanical Garden and Vale das Flores Park. Age group and average monthly income were associated with Choupal National Forest, Mondego Green Park and Vale das Flores Park. The most relevant factors influencing park use in the different parks include well-being in its different dimensions, with mental and physical well-being assessed as the main factor associated with UGS use in 4 of the 5 parks (Figure 6). Social well-being is also a relevant factor in all parks, although it has different levels of relevance. Overall, user type was the second most relevant factor in most parks, suggesting some distributive equity issues, particularly associated with the Botanical Garden and the Choupal National Forest. Accessibility and accessibility-related factors were also identified for all parks as fundamental in UGS usage, although more relevant in Vale das Flores Park and the Botanical Garden. Diverse motivations were also identified, with differences between parks. These differences also highlight the relevance of park characteristics and design, offering diverse usage possibilities. Two specific parks showed high relevance for male active users engaging in intense physical activities.

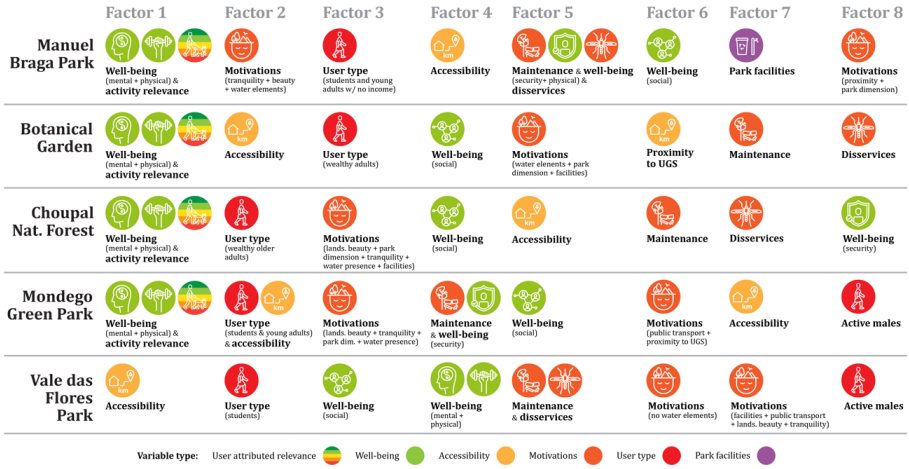

Figure 6 - Visual resume of study 4 results (based on Pinto et al., 2021a).

Overview of study 5. The results from this study on recreation preferences in Vilnius showed that *physical* and *social activities* were the most relevant group of CES-related activities, with *spiritual activities* being the least popular. The results of the EFA showed that motivations were the most relevant variables influencing all the activity groups except for *social activities* (Figure 7).

Regarding cultural activities, motivations for understanding things and learning about history were the most relevant variables. For Inspirational activities, motivations regarding developing knowledge and learning were the most important. Enjoying nature's quietness and the frequency of visits were the most relevant for Physical

activities. Motivations for developing spiritual activities and reflecting on personal religious values were the most relevant variables regarding engagement in spiritual activities. Finally, socio-demographic variables, education level, gender, and age group were found to influence social activities. As for the spatial distribution of users engaging in different activity groups, inspirational activities showed the highest dispersion of preferred locations across Vilnius, closely followed by cultural activities. On the other hand, spiritual activities registered the highest concentration in the city centre, followed by physical and social activities.

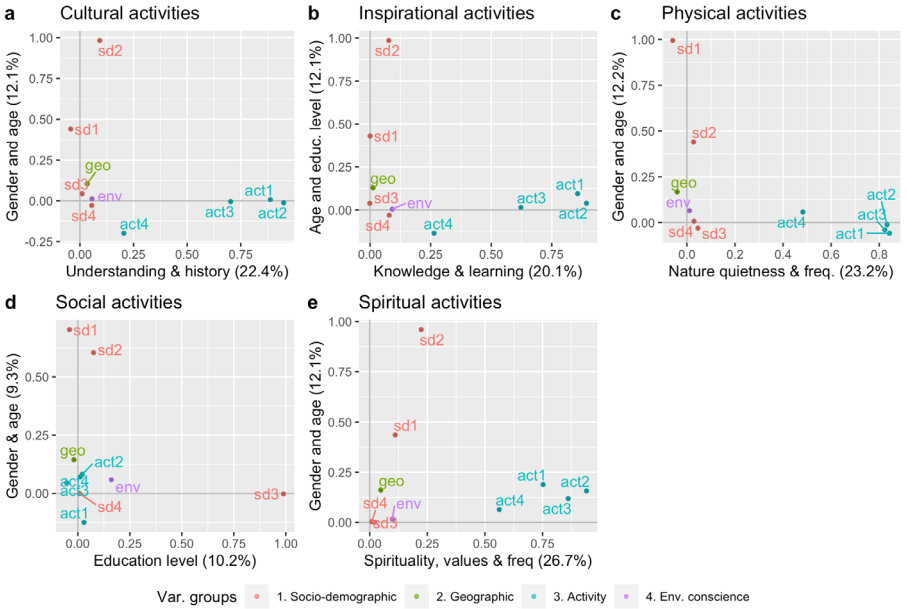

Figure 7 – First two factors linked to preferences for different groups of activities in Vilnius, Lithuania (a. Cultural activities; b. Inspirational activities; c. Physical activities; d. Social activities; e. Spiritual activities) (based on: Pinto et al., 2023b).

Overview of study 6. The developed methodology, based on a mobile app, allows for fast and accurate georeferenced data collection on observed CES-related activities, basic socio-demographic characteristics, time and seasonal factors, and park characteristics, including the spatial distribution of park recreational equipment (Figure 8).

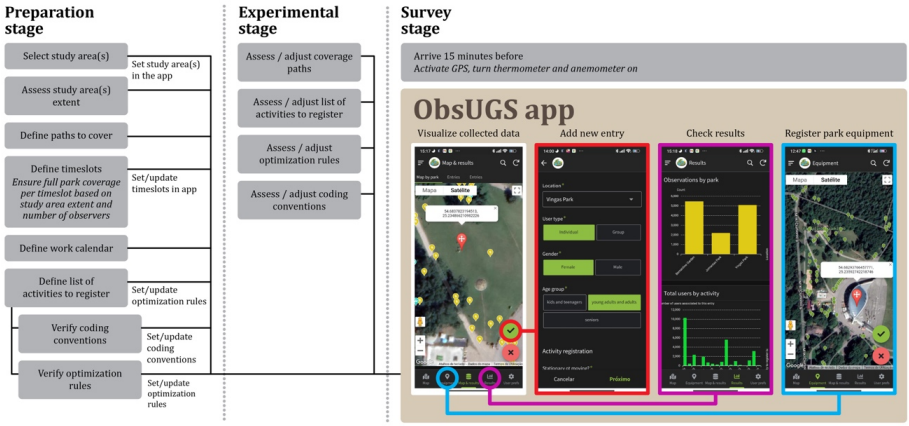

Figure 8 – Structure and workflow of the data collection method based on the mobile app prepared in study 6 (based on Pinto et al., 2023c).

Overview of study 7. The usage of the three assessed UGS in Vilnius is affected by both the observed activities and users' characteristics (Figure 9). Parks with a higher diversity of equipment (sports and cultural, e.g., Vingis Park and Bernardino Garden) had a high seasonal difference in the number of activities. The number of users was high in the summer for some activities (*activities with children*, *social*, *sports and water*). Regarding user characteristics, Jomantas Park showed low variability in user characteristics compared to the other parks. Weather variables influenced users' activities, specifically precipitation, wind speed, and air temperature. The spatial distribution of activities depended more on the available equipment than on park size. The distribution of stationary activities showed spatial correlation with park characteristics. Although the overall number of summer observations is higher than for Winter, both Vingis and Jomantas Park registered a higher number of observations during Winter for the Afternoon timeslot, with Bernardino Garden showing almost the same number for the same timeslot. The average group size per observation was higher in the summer period. *Seasonality* is the main factor explaining the variation in the Vingis Park and Bernardino Garden data. At the same time, Jomantas Park does not show relevant seasonal variation, although *weather conditions* are relevant in this last park. Assessed *activities* are relevant in both Vingis and Jomantas Parks, while *activities with children* are relevant in both Vingis Park and Bernardino Garden. *Group activities* are also relevant in both Vingis Park and Bernardino Garden. Seasonal differences were identified regarding activity groups, with social activities showing a decrease in users during Winter, while physical activities showed an increase in users for the same season. *Weekends* and *good weather* are relevant in Bernardino Garden, while *summer afternoons* are important in Jomantas Park.

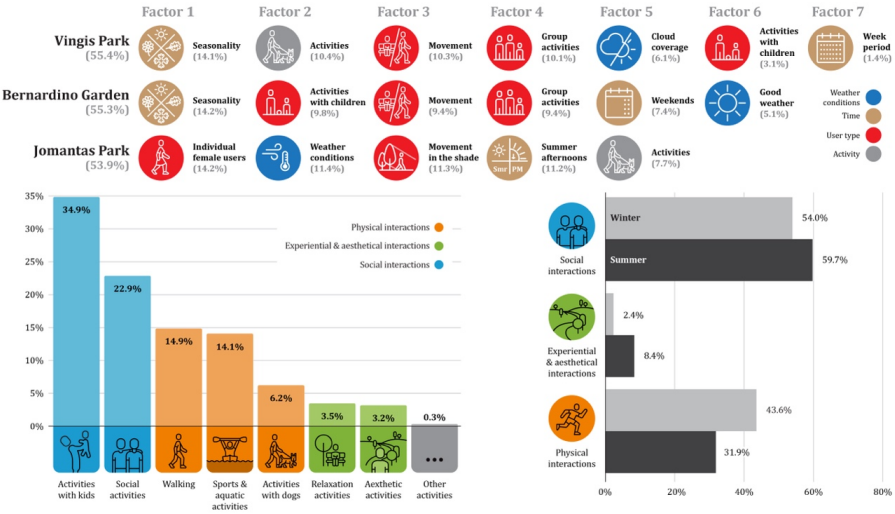

Figure 9 – Visual resume of study 7 results (based on: Pinto et al., 2024).

Overview of study 8. Results for this study focused on Oporto and showed significant differences between the assessed landscape units at the user level for all socio-demographic variables, except for the variable sex. Significant differences were also found between landscape units in terms of relevance attributed to the different landscape components. Five main factors influencing user preferences were identified (Figure 10): *comfort and security* (including vegetation density, tranquillity of space, availability of shadows, good maintenance, and forest coverage), *landscape diversity* (diversity of open spaces, diversity of flora and fauna, and presence of shrubs), *water presence*, *recreational facilities*, and *open spaces for activities*. Results also hint at distributional justice issues regarding the assessed study area.

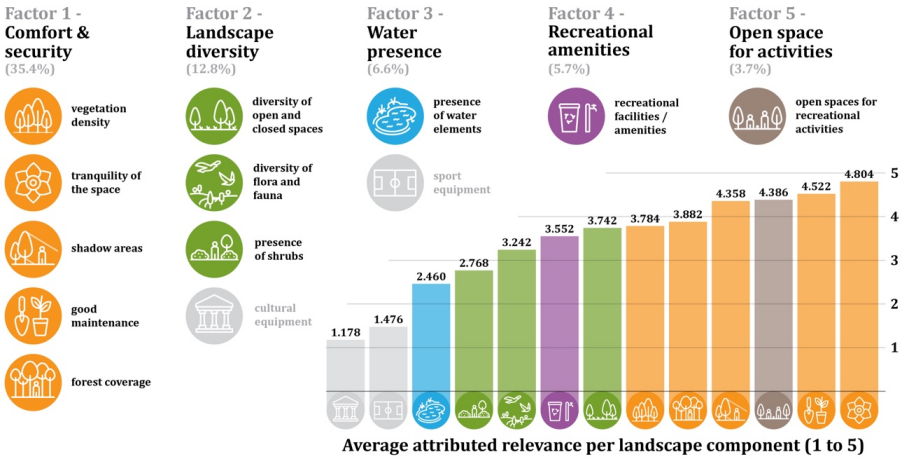

Figure 10– Visual resume of study 8 results, including the average relevance attributed to the different landscape components (5-point Likert scale, from 1 – 'Not relevant at all' to 5 – 'Highly relevant'), and identified factors from the Exploratory Factor Analysis (source: Pinto and Pereira, 2024).

5. DISCUSSION OF RESULTS

5.1 Data gathering methods

The bibliographical review and the different studies developed and implemented during the PhD work provided dual feedback. The most visible one was the wealth of information regarding preferences for the use of UGS and associated ES and well-being benefits. These results, resumed in the next subsection (and discussed in more detail in Annex 4), were used as feedback for the definition of the action modules in the data-based framework.

The less visible one was related to the effectiveness of the different methods to provide accurate, useful, and on-time data, and to the relevance of variables and factors.

Regarding data-collection methods used, all of them showed the ability to collect a broad set of data, providing relevant insights for UGS management. These methods included face-to-face interviews (studies 4 and 8), online PPGIS surveys (study 6), and observation surveys (study 7), which were described in detail in the different articles.

The Assessment of methods for data collection based on observations led to the definition of a new and specific method, which was published as a method's paper (study 5). This method was tested in the field and proved to be highly effective on minimizing the time needed to collect observation data in areas of intense use (study 7).

Accessibility to UGS was also found to be of relevance for UGS users (e.g., study 4), leading to the development of a simple method to analyse accessibility to UGS for different transport modes, in different cities (study 3), from a perspective focused on distributional justice.

The different data methods supplement each other in their ability to collect complementary information. They provided a wide range of data on user preferences for ES-related activities in UGS, was well as on perceived well-being benefits. Multiple data sources and collection methods are particularly beneficial at the municipal level, given its frequent limitations in economic and human resources (De Luca et al., 2021; Van Der Jagt et al., 2020).

These layers of information allow for a deeper knowledge and understanding of citizens' preferences and uses of UGS, which is essential for the efficient and sustainable management of these spaces (Latinopoulos, 2022). They provide ground truth data[4], essential for UGS management decision processes (Moller et al., 2019). Their relevance lies in their contribution for the alignment of planning, design, and management teams with the users' actual needs and preferences (Ugolini et al., 2022).

4 Ground truth data can be understood as information that is provided by direct observation and measurement (i.e. empirical evidence) as opposed to information provided by inference.

5.2 Variables and factors

Regarding the relevance of assessed variables and factors, the results were aggregated into three main groups which reflect relevant themes emerging from the assessment of variables. These are related to (1) UGS characteristics and well-being benefits, (2) UGS accessibility and relevance for equity, and (3) factors influencing preferences for UGS and CES use. This section presents a discussion of some of the most relevant variables and factors assessed during the PhD field work, highlighting their relevance for supporting better management decisions. Annex 4 contains a detailed discussion on all the results from the published papers.

Assessing user perceptions on the different well-being benefits obtained from a visit to an UGS can support more effective management actions focusing on the provision of safe and multifunctional spaces (e.g., study 4). E.g., social well-being benefits are often related with motivations for engaging in social relations, confirming the idea that social activities have a universal appeal across different cultures (Jim and Chen, 2006).

UGS accessibility – and the perception of accessibility – is strongly and positively linked to psychological (e.g., Liu et al., 2019) and social well-being (e.g., Peters et al., 2010; Kázmierczak, 2013; Balai Kerishnan & Maruthaveeran, 2021). Assessing accessibility to UGS can provide relevant information on potential issues related to distributional justice of UGS and associated well-being benefits.

Accessibility assessment can also provide information on issues faced by local transport networks and services. Transport options and transport preferences/needs are fundamental for informing a management framework prioritizing social inclusion and social equity. It can also provide inputs for the design of new projects related to non-motorized transport services like cycling and walking, contributing to broader sustainable goals, such as improved public health and reduced pollution, directly linked to the UN Sustainable Development Goals (SDGs).

Park size and park characteristics affect the perception of UGS availability (Rall et al., 2017). Recreational equipment (e.g., sports, cultural) are often unevenly distributed on the city fabric, imposing restrictions on UGS selection. Assessing preferences for these types of equipment can provide information on possible mismatches between offer and demand.

Park amenities like shade, seating, playgrounds, and water features where also found to be significant motivators for park visits, influencing the level of attraction of a UGS. These results are in line with other studies across the globe (e.g., Mu et al., 2021, Holman et al., 1996, Refshauge et al., 2012). As such, they should be assessed regarding both availability and maintenance status.

Several user socio-demographic characteristics were found to influence the engagement in CES-related recreational activities, which aligns with results from other studies (Hegetscheiler et al., 2017). E.g., age and economic conditions affect accessibility to UGS, with older users avoiding distant UGS, or wealthier users looking for better equipped UGS, even if more distant (e.g., Neuvonen et al., 2010; Rossi et al., 2015; Sun

et al., 2019; Wen et al., 2020).

User motivations were found to be fundamental regarding recreational activities in Vilnius (Study 5), similar to results from other studies (e.g., Bjerke et al., 2006). Furthermore, motivations were influenced by park characteristics. E.g., motivation for enjoying tranquillity in nature, or for enjoying the view towards a beautiful landscape, can be greatly improved by the presence of water elements. Information on user motivations is thus relevant for functional and ecological management processes.

Time related variables are another type of variables which are also relevant to support UGS management. E.g., seasonality allows for the assessment of seasonal changes in UGS usage. It also allows to assess preferences for winter-related activities, such as winter sports in snowy areas. This information can be particularly relevant in regions registering large contrasts in climatic conditions between seasons. Furthermore, the intensity of use often shows significant differences between seasons, but also between week periods, and even day periods. As such, these variables, and their implications in user preferences for ES-related activities, need to be considered by UGS management teams (Guan et al., 2021).

Park characteristics related to landscape components influence user perceptions on, e.g., comfort and safety, or landscape diversity. This has implications in the choices

Figure 11 shows a resume of the main variables and factors found relevant across the different studies implemented during this PhD.

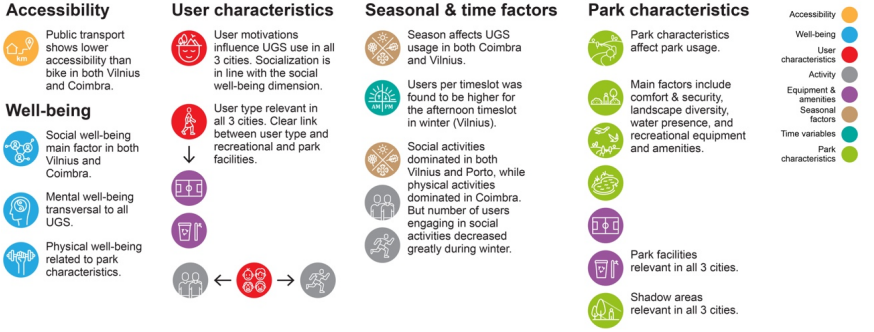

Figure 11 – Relevant variables and factors assessed during PhD work

Despite these benefits, UGS may also present drawbacks. Issues as safety concerns, the presence of invasive species, or inadequate maintenance can deter UGS usage. Additionally, environmental justice issues can arise, as proximity to UGS can impact housing prices, contributing to social exclusion and gentrification. Addressing these challenges through data-based management frameworks which consider local characteristics regarding UGS accessibility, user demographics, and park features can maximize UGS benefits and promote inclusivity, supporting well-being and environmental justice in urban areas.

These results are also a fundamental part of the information used to build the data-driven framework.

5.3 Limitations

Each developed study had its specific limitations.

Study 1. The coverage of English peer-reviewed papers might need more access to pertinent papers published in other languages, thus introducing geographical bias. Most papers did not follow the CICES v5.1 classification, making the classification extremely difficult. The use of well-being dimensions, according to CICES v4.3, might be limited to this area of research.

Study 2. This review focused on a limited set of search keywords, which might have provided a limited number of articles as the basis for the paper. The NbS concept is open, failing to gather a consensual view. The types of UGBI and NbS identified are not exhaustive.

Study 3. Accessibility modelling can be affected by the availability and quality of the base information. Freely available OSM data faces specific challenges regarding spatial coverage homogeneity and precision. We verified and corrected data through field verification and Google Earth checking to minimise potential issues. Available census data from 2011 was also a limiting factor, which should be addressed in future research with newer data as soon as it becomes available. The identification of UGS areas based on official land use master plans from local authorities has two issues: the need for the homogenisation of land use classes related to UGS to ensure effective comparison of available UGS with non-restricted access for the public and the use of proposed land use, with some recreational UGS not yet established. Despite these issues, using official master plans is beneficial in fostering a potential practical application of the results.

Study 4. Face-to-face interviews have limitations regarding registering users engaged in intense sports activities (e.g., bikers, runners, water sports), making it difficult to interrupt and question them. The survey was implemented only during the summer period and, as such, cannot be considered representative of an annual use of the study areas. This survey was developed during the COVID-19 pandemic, with partial lockdown. Given their status as a risk group, this made us worry about addressing older adults. As such, this age group might have been underrepresented. Given the pandemic and partial lockdown, collected data might represent a different reality than the one existing in pre-pandemic times. This might have given prevalence to users visiting UGS also as a way of coping with emotional stress and well-being issues.

Study 5. The study focuses exclusively on Vilnius inhabitants (residents), although many tourists and external visitors visit Vilnius' UGS. This limitation was however relevant to ensure statistical representability. The number of activity groups was limited to 5, merging different individual activities. This might reduce the level of detail of the study. However, this was considered necessary to ensure effective and valid participation and data management. A limited set of motivation items from the REP scales were used for the same reason.

Study 6. The limitations of a data collection method based on observations are mostly linked to the inability to collect qualitative information regarding user

preferences or motivations.

Study 7. Some activities are not explicit, so a conversation with the users is needed to correctly identify them, e.g., meditation. Walking can have two main interpretations: a physical activity or a transport mode needed for a specific task. However, most of the time, this is not distinguishable by observation. The evening timeslot was assessed only during summer due to short daylight and safety concerns in Winter. Detailed age groups are not easily identified by observation, so we opted for a coarser classification. Nevertheless, the observation method allowed us to collect a large amount of data, which would never be possible through face-to-face surveys, adding value to the overall work.

Study 8. Given the absence of official data, our sample of users might not be statistically representative of park users, which could have guided us in the sampling definition. The dataset corresponds to a specific set of landscape units, in a specific park, of a specific city, with results not necessarily representing a general panorama of UGS.

6. IMPLICATIONS FOR MANAGEMENT

Numerous studies have highlighted the contribution of UGS to human well-being (e.g., Kothencz et al., 2017). As previously stated in section 2.1, they are key to alleviating environmental-related challenges in urban areas, such as pluvial floods, heat waves, and increased air and soil pollution, derived from climate change, urban population growth, and the intensification of urban traffic.

This section presents an integrated resume of the implications for management assessed in the different studies. Integrated and holistic interventions are needed to optimise the positive impacts provided by UGS in urban areas, but these holistic interventions must always be defined based on local characteristics, e.g., climate conditions, distinct spatial constraints, and different social and political characteristics (Barreira et al., 2023).

Several aspects need to be considered in their design, implementation, and management to contribute towards sustainable development and human well-being via the provision of a wide array of ES while controlling and reducing potential disservices.

Comfort and security are fundamental aspects for UGS users, and recreational usage ranges from experiential and relaxing activities to intense physical activities. Thus, multifunctionality is one critical aspect of UGS design.

To counter the potential environmental justice issues associated with UGS development, research has suggested the 'just green enough' approach, involving planning and implementation of a network of smaller UGS, spread along the urban fabric (e.g., Chen et al., 2021; Sun et al., 2023; VanderWilde, 2017). This approach shows economic and social advantages, with the reduction of both maintenance costs and gentrification impacts. This method should include the re-conversion of informal UGS (e.g., brownfields), which is beneficial in reducing environmental justice regarding UGS availability for vulnerable groups, such as children and seniors (Sikorska et al., 2020).

National and local authorities should regulate real estate prices and soil value to counter an increase in housing prices associated with green investment, as suggested by Rodríguez-Pose and Storper (2020). This also needs to be carefully addressed with a holistic approach to avoid missing any issue that might compromise its effectiveness while considering local characteristics.

A bottom-up approach is fundamental for including local stakeholders' needs and expectations, as defended by several authors (e.g., Sun and Chen, 2019). This can improve involvement and a sense of ownership and belonging, reducing maintenance costs and improving ES quality. Furthermore, local authorities should implement – and foster among its workers – a long-term adaptable vision of a green and sustainable city. UGS must be clearly viewed as a valuable and critical infrastructure at the same level of communication, energy, or water supply infrastructures. According to the World Health Organization (2017), UGS projects should be considered a public health and social investment to reinforce their importance in urban planning and design. This falls within the green public administration concept.

Regarding sustainability and environmental justice of accessibility to UGS, we

suggest an investment on efficient intermodality, including: (1) promotion of shared mobility, including the optimisation of public transport services, e.g., maximising short time accessibility to UGS through the creation of new bus lines specifically oriented for UGS access, and the addition of new bus stops to increase population coverage; this is particularly relevant for both Coimbra and Vilnius; (2) promotion of non-motorised transport modes, contributing for increased physical and emotional well-being, as well as reduced noise and air pollution levels; Vilnius shows a solid adherence for non-motorised transport, in part due to its natural conditions – shallow slopes – and its urban development – wide streets allowing for the implementation of bike lanes; on the other side of the spectrum, both Coimbra and Porto still need further investment on non-motorised priority lanes; and (3) implementation of car restrictions initiatives, e.g., areas of restricted access to private vehicles, or speed limits and parking time limits.

This approach can contribute to increased well-being at different dimensions (Mouratidis et al., 2023). E.g., mental and physical well-being levels increase due to physical activity. Physical security also increases due to reduced air pollution levels and accident exposure due to lower traffic volume. Examples across Europe have shown the effectiveness of several types of interventions towards the reduction of car use (Kuss & Nicholas, 2022).

Additionally, UGS design and management needs to equate clear measures to address critical near-future issues such as water shortage, increase in frequency and intensity of heatwaves and rainfall episodes, or intensification of the use of UGS. Measures should be integrative and sustainable, involving local knowledge, and based on NbS.

UGS design and management must consider changes in seasonal use of UGS, with the winter season conditions closer to those found during spring or summer, associated with a potential increase in the number of users and intensity of use during this period, contributing as stress factors for both vegetation and soil quality (Shuhani et al., 2023). Thus, adaptation through preventive design is needed. Design and adaptation measures are always context-related, i.e., they need to take into consideration local specificities, such as severe winter seasons, as is the case of Vilnius, or hot and dry summers, as in Coimbra, or wet and windy mid-seasons in Porto. Due to its relevance for the near future, it is also critical to consider climate-change scenarios. Efficient green urban governance is based on multi-sectoral development teams, including specialists from different areas, fundamental to tackling the growing complexity of environmental and equity problems associated with continuous urban growth.

7. PROPOSALS

There is a critical need for accurate data to support the management of sustainable UGS, with municipalities often faced with discrepancies between collected and needed data (Sörensen et al., 2021). The use of different data types for holistic urban planning is essential (Sörensen et al., 2021), as it is the need to address data gaps in urban datasets (Rambhia et al., 2024).

As such, this thesis proposes a data-based framework to bridge information gaps and enhance UGS inclusion in the global urban management processes. The proposed data-based management framework is supported on an overarching and innovative data-collection module, based on the results from the developed research. This data-collection module includes the assessment of physical accessibility to UGS and the assessment of a broad set of variables directly and indirectly linked to the use of UGS, via different data collection modes. These variables include socio-demographic characteristics, UGS characteristics, weather variables, and time-related variables. Accessibility assessment should be based on GIS network analysis for different transport methods, including, at least, walking, biking, and public transport. For the collection of data regarding the other variables, a diversity of survey types should be included, namely face-to-face surveys, observation surveys, and online public participation GIS surveys. A specific data collection method based on observations was developed (Paper 5), focused on data collection efficiency and accuracy. This method adds diversity to the data collection methods, as well as to the ground truth base data supporting efficient decision making in the framework. For the monitoring and evaluation module, the framework also recommends an online tool for the collection of user generated data on their perceptions of the UGS condition and satisfaction level.

7.1 Data-based framework for the management of UGS

The proposed data-based management framework is schematized in Figure 11. The module on Data collection and analysis (highlighted module) integrates the results from the assessment on data-gathering methods. The different modules are briefly described in the next subsections. This framework integrates data-driven insights, stakeholder engagement, and a holistic approach to park management, aiming to enhance the quality, accessibility, and sustainability of UGS, also dealing with environmental justice issues. Specific actions for several modules of the framework are detailed in section 7.2. Although generic, the framework can be implemented locally, thanks to the assessment and integration of local specificities derived from the data collection module, which is the base of the framework.

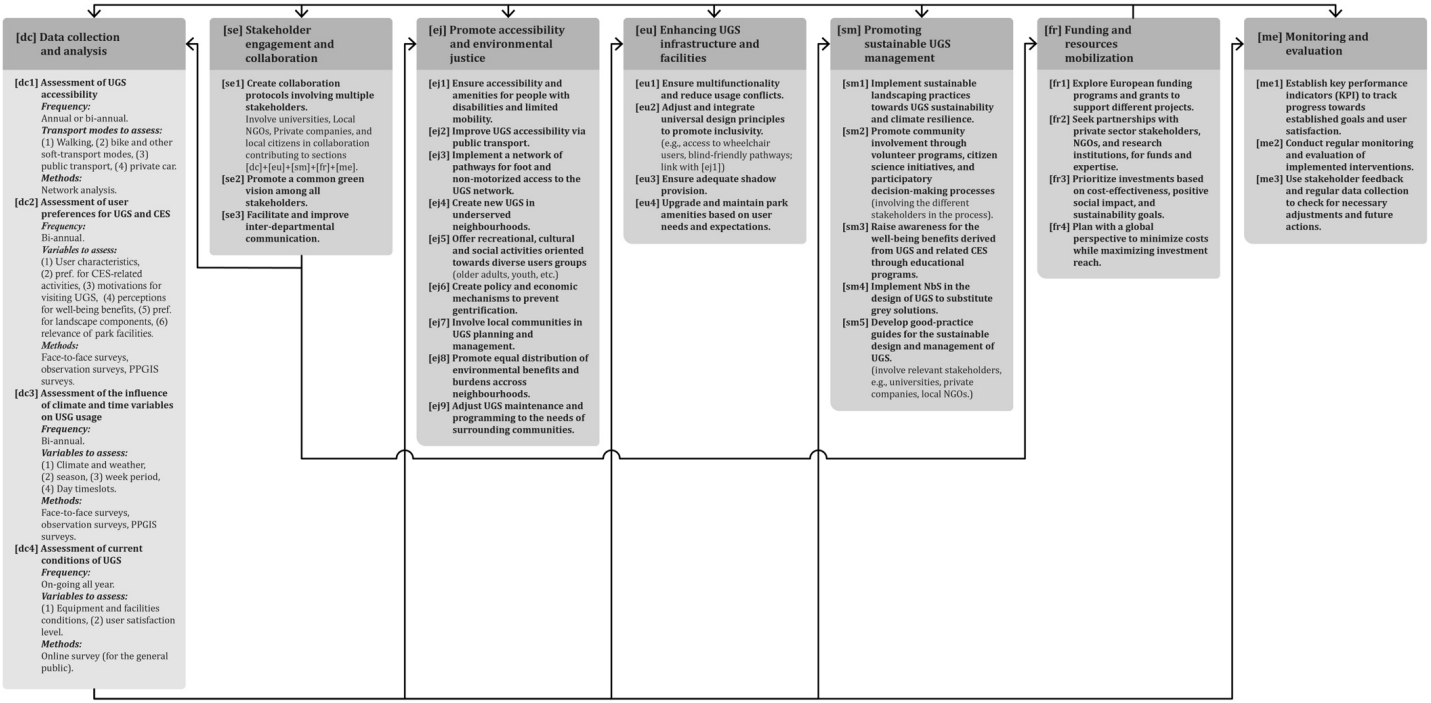

Figure 11 – Proposed structure of a data-based management framework for UGS. Main contribution of this thesis highlighted in brown, corresponding to module [dc] Data collection and analysis.

7.1.1 Data collection and analysis [dc]

Utilize Geographic Information Systems (GIS) for comprehensive accessibility analyses, considering various transport modes (walking, cycling, public transit, private vehicles).

Conduct surveys (face-to-face + observation + online PPGIS) to gather insights into user preferences, including activities, amenities, and concerns related to park usage. Create synergies with universities and local non-governmental organizations (NGOs) to create and implement data-gathering protocols regarding (a) preferences for UGS use, (b) UGS maintenance status, (c) identification of derelict / expectant areas with potential to be converted into UGS. Using the same synergies, joint studies should be made regarding the creation of a network of pocket gardens, promoting the link between available UGS. Analyse existing park characteristics, policies, and management practices to identify strengths, weaknesses, opportunities, and threats.

7.1.2 Stakeholder engagement and collaboration [se]

Facilitate communication and collaboration among different management departments and stakeholders to address challenges and implement effective solutions. Promote a common green vision among all stakeholders.

Establish multi-stakeholder partnerships to leverage diverse expertise and resources for park management and improvement initiatives. Link to 7.1 for the production of data collection protocols, and regular data-collection implementation.

7.1.3 Promote accessibility and environmental justice [ej]

Ensure that UGS have accessible pathways, entry points, and amenities for people with disabilities or limited mobility. Provide free or low-cost transportation options to reach UGS. Improve public-transport accessibility to UGS by considering them as potential travel destinations in the planning of transport systems. Assess and propose UGS in underserved neighbourhoods to improve access for low-income communities.

Offer programs and activities tailored to diverse user groups (older adults, youth, etc.).

Mitigate displacement risks and preserve affordability in neighbourhoods near new green infrastructure. Involve local communities, particularly marginalized groups, in the planning and management of UGS. Address unequal distribution of environmental benefits and burdens across neighbourhoods. Ensure that UGS maintenance and programming meets the needs of the surrounding community.

7.1.4 Enhancing UGS infrastructure and facilities [eu]

Ensure efficient and non-clashing distribution of equipment and facilities, ensuring multifunctionality in UGS design minimizing or eliminating potential usage conflicts.

Integrate universal design principles, adjusted to local characteristics, to improve accessibility for people with disabilities and promote inclusivity, e.g., provide easy access to wheelchair users, or create blind-friendly pathways in specific areas of the UGS.

Address concerns related to availability of shadow areas.

Upgrade and maintain park amenities (e.g., seating areas, playgrounds, restrooms) based on user preferences and needs identified through surveys.

7.1.5 Promoting sustainable UGS management [sm]

Implement sustainable landscaping practices to enhance biodiversity, ecosystem services, and climate resilience within UGS.

Encourage community involvement through volunteer programs, citizen science initiatives, and participatory decision-making processes.

Develop educational programs and interpretive signage to raise awareness about the ecological value and benefits of urban green parks for human well-being.

Implement NbS in the design of UGS whenever possible to substitute grey solutions.

Develop good-practice guides for the management of UGS, including suggestions on vegetation species, UGS facilities, sport, and cultural equipment, adaptation to climate change, multifunctionality.

7.1.6 Funding and resource mobilization [fr]

Explore European funding programs and grants to support the costs of new projects, infrastructure upgrades, and capacity-building activities.

Seek partnerships with private sector entities, non-governmental organizations (NGOs), and research institutions to access additional funding and expertise.

Prioritize investments based on cost-effectiveness, social impact, and alignment with long-term sustainability goals. Optimize the planning of multiple projects to minimize costs and maximize investment reach.

7.1.7 Monitoring and evaluation [me]

Establish key performance indicators (KPIs) to track progress towards enhancing UGS utilization, safety, and visitor satisfaction.

Conduct regular monitoring and evaluation to assess the effectiveness of implemented interventions and identify areas for further improvement.

Use feedback from stakeholders and ongoing data collection efforts to adapt management strategies and prioritize future actions.

7.2 Specific actions under each framework module

This section lists a detailed set of actions for each framework module. These actions are linked to our findings. One of the concepts driving the different proposals is the integration among the different actions, to maximize the efficiency of allocated budget and resources.

There are several limiting factors associated with the implementation of actions such as those proposed in the framework. These include, e.g., increased expenses related to the construction of new infrastructures such as cycleways and pathways (Kabisch, 2015). Political will can also be a primary barrier to UGS implementation, linked to several issues, such as organisational characteristics, real estate pressures, legislation limitations, or urban densification (Gavrilidis et al., 2020; Pereira and Baró, 2022). And sustainability issues due to an increase in water needs (e.g., Yang and Wang, 2017), or the increase in wildfire risk due to the presence of large areas with high levels of biomass (Modugno et al., 2016).

These issues highlight the need to consider local specificities in establishing UGS, e.g., including developing strategies to mitigate water consumption and wildfire risk. As such, for each action we indicate its applicability to each case study, also identifying the relevant agents inside each municipality, which will be responsible, or involved, in the different actions. Considering the need to evaluate the effectiveness and implications of the implementation of these measures, we also propose a set of key performance indicators (KPI), originally based on Carmen et al. (2020).

In the following sub-sections, we detail all actions for both the [dc] data collection and [se] stakeholder engagement and collaboration modules. We also detail a selection of actions from the other framework sections.

Each action includes a brief definition of (1) the steps needed for their implementation, (2) the potential outcomes, (3) application to the different case studies, (4) responsible actors, (5) involved stakeholders, (6) funding opportunities, (7) KPI, and (8) periodicity.

The flexibility of the framework allows for the definition of common modules and actions which can be applied by the different case studies. The main difference between them is at the level of the definition of priorities of investment, which is adjusted according to each local reality, both in terms of available funds, as well as in social, economic, and ecological characteristics and priorities, which are evaluated inside the framework itself.

Regarding specific measures for the assessed case studies, we can highlight the need for a more efficient public transport network in Vilnius and Coimbra. The introduction of more bus stops and UGS-oriented bus lines would improve accessibility by public transport in Vilnius. Coimbra also needs changes in its public transport network and a deep investment in implementing a wider and more efficient UGS network. Regarding Porto, the assessed park showed issues related to distributional justice, which were expected to some extent due to its large size and location on the city's western limits.

Concerning funding opportunities, based on our initial assessment for the

2021-2027 period, we suggest a diversification of fund submission in the Lithuanian case, regarding intervention fields under SO5.1 of the EU PO5 – Europe Closer to Citizens (Table 5, section 3.1.1.). In the Portuguese case, a stronger investment should be made on social equity, similar to the Lithuanian case.

7.2.1 Actions for framework module [dc] on data collection

Action ID	[dc1]		
Action	**Assessment of UGS accessibility**		
Steps	Set up a protocol with a local university to engage a master student, on a yearly basis, to assess the accessibility to UGS for different transport modes (walking, bike and other non-motorized soft-transport modes, public transport, private car). Methods: GIS network analysis. Share the results with the relevant municipal departments.		
Outcomes	Implementation will provide data to support decision and design of accessibility measures for framework section [ej].		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) culture, sports, and tourism; (2) architecture and spatial planning.	Municipal departments of: (1) environmental planning and management; (2) green spaces and infrastructure management.	Municipal department of environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIB, ERDF, ERC, ESF+, Horizon Europe. Under specific objectives SO2.8 Sustainable urban mobility + SO3.2 Sustainable transport.		
KPI	% of population with accessibility to UGS under 15 min. walking and public transport / 5 min. bike or car % of urban are covered with accessibility to UGS under 15 min. walking and public transport / 5 min. bike or car		
Periodicity	Annual		

Action ID	[dc2]		
Action	**Assessment of user preferences for UGS and CES**		
Steps	Set up a protocol with a local university to engage students from a geography or social science class to engage in field work, collecting data on user preferences, motivations, and perceptions for well-being benefits, for UGS usage and CES-related activities. Methods: face-to-face surveys, observation surveys, PPGIS surveys. The protocol can also assess the possibility for the development of citizen-science projects, to increase public participation in the surveys. Methods: PPGIS surveys, citizen-science mobile apps. Share the results with the relevant municipal departments.		
Outcomes	Implementation will provide data to support decision and design principles for UGS for framework sections [ej], [eu], and [sm].		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) culture, sports, and tourism; (2) architecture and spatial planning.	Municipal departments of: (1) environmental planning and management; (2) green spaces and infrastructure management.	Municipal department of environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO5.1 Integrated development in urban areas.		
KPI	Ranking of CES-related activities. Diversity of preferred CES-related activities.		
Periodicity	Annual or bi-annual		

Action ID	[dc3]
Action	**Assessment of climate influence on UGS use**
Steps	Set up a protocol with a local university to engage students from a geography and environmental science classes to engage in field work, collecting data on how climate and weather influence UGS usage and preferences for CES-related activities. Methods: face-to-face surveys, observation surveys, PPGIS surveys. The protocol can also assess the possibility for the development of citizen-science projects, to increase public participation in the surveys. Methods: PPGIS surveys, citizen-science mobile apps. Share the results with the relevant municipal departments.
Outcomes	Implementation will provide data to support decision and design principles for UGS for framework sections [ej], [eu], and [sm]

Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) culture, sports, and tourism; (2) architecture and spatial planning.	Municipal departments of: (1) environmental planning and management; (2) green spaces and infrastructure management.	Municipal department of environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO5.1 Integrated development in urban areas.		
KPI	seasonal differences in CES-related activities.		
Periodicity	Annual		

Action ID	[dc4]		
Action	**Assessment of current conditions of UGS**		
Steps	Set up a protocol with a local university to engage students from a geography or social science class to engage in field work, collecting data on current condition, and user perceptions of conditions, of available UGS. Methods: face-to-face surveys, observation surveys, PPGIS surveys. The protocol can also assess the possibility for the development of citizen-science projects, to provide direct public feedback from UGS users on the spot. Methods: PPGIS surveys, citizen-science mobile apps. Share the results with the relevant municipal departments.		
Outcomes	Implementation will provide data to support management decisions for UGS for framework sections [ej], [eu], and [sm]		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal department of architecture and spatial planning.	Municipal department of green spaces and infrastructure management.	Municipal department of environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	level of satisfaction regarding UGS maintenance.		
Periodicity	Annual		

7.2.2 Actions for framework module [se] on stakeholder engagement and collaboration

Action ID	[se1]		
Action	**Create collaboration protocols with multiple stakeholders**		
Steps	Contact local universities to promote the creation of protocols for actions related to the framework sections [dc] and [me]. Contact private companies and NGOs for the possible involvement, both in human and economic resources, regarding the implementation of the vision on a green city – action [se2].		
Outcomes	The protocols will support the implementation of actions from framework sections [dc] and [me]. They will also contribute towards framework section [fr].		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal department of architecture and spatial planning.	Municipal departments of green spaces and infrastructure management.	Municipal departments of environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, private companies, local communities	University of Porto, local NGOs, private companies, local communities	University of Coimbra / Coimbra Polytechnic University, private companies, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.3 Growth and competitiveness of SMEs + SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO2.8 Sustainable urban mobility + SO4.2 Education and training infrastructure + SO5.1 Integrated development in urban areas.		
KPI	# of protocols created. # of stakeholders involved.		
Periodicity	Annual		

Action ID	[se2]
Action	**Creation of a long-term adaptable vision of a green city within local authorities themselves**
Steps	Engage relevant municipal departments on the development of a long-term adaptable vision for a green city, focused on subjects such as sustainable development, environmental and social justice, green accessibility, integration of NbS. Engage local stakeholders and local inhabitants in the definition of the green vision for the city, through participatory methods (linked to action [sm2]). Promote negotiations between different and conflicting interests, to ensure acceptable compromises, which can ensure an effective implementation of the green vision. Integrate the vision in strategic and planning documents.
Outcomes	This action will promote internal communication and the creation of a common focus and goal, towards supporting effective sustainable development measures, also contributing towards action [se3]. It will also serve as the basis for framework sections [ej], [eu], [sm], and [me].
Case studies	□ Vilnius □ Porto □ Coimbra
Responsible	Municipality
Stakeholders	All municipal departments, local NGOs, local communities.
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.1 Energy efficiency + SO2.4 Climate change adaptation + SO2.5 Sustainable water + SO2.6 Circular economy + SO2.7 Nature protection and biodiversity + SO2.8 Sustainable urban mobility + SO5.1 Integrated development in urban areas.
KPI	# of projects focused on green development. Changes in perception on green vision adoption from internal survey.
Periodicity	Annual

Action ID	[se3]
Action	**Facilitate and improve inter-departmental communication**
Steps	Promote regular (trimestral) inter-departmental meetings focused on discussing issues and problems related to collaboration towards the implementation of the green vision.
Outcomes	This action will promote integrated actions between departments, reducing silos and contributing towards unified interventions and implementation of sustainable development concepts and tools, such as ES and NbS. It will have positive contributions towards framework sections [ej], [eu], [sm], and [me].
Case studies	□ Vilnius □ Porto □ Coimbra
Responsible	Municipality
Stakeholders	All municipal departments.
Funding opportunities	Funds: internal funds.
KPI	# of projects focused on green development. Internal survey on green vision adoption.
Periodicity	Trimestral or more frequent

7.2.3 Actions for framework module [ej] on promoting accessibility and environmental justice

Action ID	[ej1]		
Action	**Ensure accessibility and amenities for people with disabilities and limited mobility**		
Steps	Assess accessibility needs and constrains in available UGS, Based on results from step 1, provide wheelchair accessibility to assessed UGS and ensure a minimum area inside the UGS where people with disabilities can interact with nature without physical constrains.		
Outcomes	The measure will improve environmental and distributional justice through the provision of easier access to disadvantaged populations.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning, (2) social services for family and children.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) public space, (4) social cohesion.	Municipal departments of: (1) environment and sustainability, (2) mobility, transit and transportation, (3) social action and housing.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF. Under specific objectives SO4.3 Integration of marginalized communities + SO4.8 Active inclusion and employability + SO5.1 Integrated development in urban areas.		
KPI	# and evolution of complaints for restricted access to UGS # and evolution of accessibility measures implemented # and evolution of percentage of UGS with friendly-access interventions		
Periodicity	Annual		

Action ID	[ej2]		
Action	Improve UGS accessibility via public transport		
Steps	Define UGS accessibility as a priority for public transportation. With the input from action [dc1], identify population areas with limited accessibility (over 15-minute accessibility). Identify public transport lines with limited coverage for these areas, and identify potential stops, which can enhance access to UGS. Implement changes in the public transport network to solve these issues.		
Outcomes	The measure will improve distributional justice in UGS accessibility.		
Case studies	□ Vilnius	□ Porto	□ Coimbra

Responsible	Municipal department of architecture and spatial planning, Municipal public transport enterprise MESP.	Municipal departments of: (1) green spaces and infrastructure management; (2) mobility.	Municipal departments of: (1) environment and sustainability; (2) mobility, transit and transportation.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIB, ERDF, ERC, ESF+, Horizon Europe. Under specific objectives SO2.8 Sustainable urban mobility + SO3.2 Sustainable transport.		
KPI	user satisfaction surveys, % of population covered by under 15-minute access by bus to UGS.		
Periodicity	Annual		

Action ID	[ej4]		
Action	**Create new UGS in underserved neighbourhoods**		
Steps	Assess UGS coverage based on results from action [dc1] and identify underserved neighbourhoods. Identify vacant plots, expectant land, other brownfield areas, or small natural areas, and assess the feasibility of including them in a connected network of recreational UGS, based on pocket and community parks (areas between 0.5 ha and 1.0 ha). Involve local communities and local NGOs in the identification of preferences for UGS and CES-related activities, as well as for recreational equipment. Use also results from action [dc2]. Plan and design for multifunctionality. Consider a progressive plan of action to ensure a progressive and geographically evenly distributed implementation process, to avoid undesired gentrification issues.		
Outcomes	The measure will improving distributional, procedural, and recognitional equity in the access to UGS.		
Case studies	□ Vilnius	□ Porto	□ Coimbra

Responsible	Municipal departments of: (1) architecture and spatial planning, (2) culture, sports, and tourism, (3) land management.	Municipal departments of: (1) green spaces and infrastructure management; (2) environmental planning and management; (3) urban management; (4) studies and urban projects; (5) public space.	Municipal departments of: (1) environment and sustainability; (2) urban management; (3) youth and sports; (4) strategic studies, planning and territorial development.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF. Under specific objectives SO4.3 Integration of marginalized communities + SO4.8 Active inclusion and employability + SO5.1 Integrated development in urban areas.		
KPI	User satisfaction surveys. UGS area per inhabitant. Global area of UGS per UGS type.		
Periodicity	On a needed basis		

Action ID	[ej6]
Action	**Create policy and economic mechanisms to prevent gentrification**
Steps	In cooperation with universities, research centres, and local NGOs, assess validity and efficacy of affordable housing policies, including (a) inclusionary zoning laws setting a percentage of new housing developments to be affordable, and (b) rent control / rent stabilization policies to limit rent increases. Similarly, assess efficacy of economic development policies including (a) tax increment financing (TIF) programs to reinvest increased property tax revenues into the community, (b) small business assistance programs to help existing businesses to stay in the area, (c) job training, workforce development, and voluntary programs to connect residents to green-related economic opportunities, (d) investment in public infrastructure and amenities benefiting existing residents. Assess anti-displacement measures, such as (a) just-cause eviction laws to protect tenants from arbitrary or retaliatory evictions, (b) community benefit agreements requiring developers to mitigate the impact on the local community. Implement all relevant measures.
Outcomes	The measure will maximize CES availability, while improving distributional, procedural, and recognitional equity in the access to UGS.
Case studies	□ Vilnius □ Porto □ Coimbra

Responsible	Municipal departments of: (1) architecture and spatial planning, (2) land management, (3) social welfare, (4) infrastructure development.	Municipal departments of: (1) urban planning, (2) green spaces and infrastructure management; (3) environmental planning and management; (4) urban management; (5) studies and urban projects; (6) public space, (7) social cohesion.	Municipal departments of: (1) environment and sustainability; (2) urban management; (3) strategic studies, planning and territorial development, (4) social action and housing.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF. Under specific objectives SO4.3 Integration of marginalized communities + SO4.8 Active inclusion and employability + SO5.1 Integrated development in urban areas + SO8.1 Just transition fund.		
KPI	% of displaced population after implementation of UGS projects. Comparison between average rent prices before and after intervention. Comparison between average housing prices before and after intervention.		
Periodicity	On a needed basis		

7.2.4 Actions for framework module [eu] on enhancing UGS infrastructure and facilities

Action ID **Action**	[eu1] **Ensure multifunctionality and reduce usage conflicts**		
Steps	Assess multifunctionality characteristics in the available UGS, supported in action [dc4], Based on results from actions [dc2] and [dc3], draft a first proposal for relevant types of CES-related activities to be fostered in the different UGS. Compare UGS characteristics (step 1) and proposals from step 2, to check for space availability and compatibility between functions. Involve local population through participatory processes in the evaluation of the first proposal from step 2, and eventual development priorities. Examples include the distinction between spaces for relaxation, socialization, for moderate physical activities, and for intense physical activities. Establish priorities and find funding resources to implement them.		
Outcomes	The measure will improve CES provision, contributing towards well-being benefits.		
Case studies	□ Vilnius	□ Porto	□ Coimbra

Responsible	Municipal departments of: (1) architecture and spatial planning, (2) culture, sport, and tourism.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) public space, (4) urban planning.	Municipal departments of: (1) environment and sustainability, (2) urban management, (3) youth and sports, (4) studies and urban projects, (5) environmental planning and management.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.7 Nature protection and biodiversity + SO4.2 Education and training infrastructure + SO5.1 Integrated development in urban areas.		
KPI	# of projects explicitly considering multifunctionality in their development. Degree of potential usage diversity. Level of citizen involvement.		
Periodicity	On a needed basis.		

Action ID	[eu2]		
Action	Adjust and integrate universal design principles to promote inclusivity		
Steps	Assess current UGS state regarding universal access and inclusivity. Link with action [ej1]. Define intervention priorities to promote and implement universal design principles such as (a) accessible pathways, (b) variety of seating options, (c) multi-sensory experiences, (d) inclusive play spaces, (e) include native plantings and wildlife habitats (for education, recreation, and relaxation opportunities), (f) clear signage and wayfinding, (g) universal access to facilities.		
Outcomes	The measure will improve environmental and distributional justice.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning, (2) social services for family and children.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) public space, (4) social cohesion.	Municipal departments of: (1) environment and sustainability, (2) mobility, transit and transportation, (3) social action and housing.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities

Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO4.3 Integration of marginalized communities + SO4.8 Active inclusion and employability + SO5.1 Integrated development in urban areas.
KPI	# of complaints for restricted access to UGS # of universal design principles implemented % of UGS with universal design principles interventions
Periodicity	On a needed basis.

Action ID	[eu3]		
Action	**Ensure adequate shadow provision**		
Steps	Assess shadow coverage in all UGS, Based on results [dc2] and [dc3], as well as on UGS type and main goals, assess the relevance and viability to implement a 40% exposed, 20% mid-shade, 40% shadow share. Promote the use of native species and species with low water requirements. Set intervention priorities and find adequate funds. Implement measure.		
Outcomes	The measure will provide well-being benefits, also contributing to resilience to climate change effects, and overall sustainability.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) environmental planning and management.	Municipal departments of: (1) environment and sustainability, (2) urban management
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	% of exposed, mid shade, and shadow areas.		
Periodicity	Annual		

Action ID	[eu4]		
Action	**Upgrade and maintain park amenities based on user needs and expectations**		
Steps	Assess status of UGS regarding park amenities, based on [dc2] and [dc4], Based on results from step 1, consider the incorporation of recreational facilities, e.g., benches, water fountains, garbage bins, toilets, harmonized with the natural environment, adequately spaced, easily accessible, and properly maintained. Set intervention priorities and find adequate funds. Implement measure.		
Outcomes	The measure will improve well-being benefits and maximize provision of CES.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) environmental planning and management.	Municipal departments of: (1) environment and sustainability, (2) urban management
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO4.2 Education and training infrastructure + SO5.1 Integrated development in urban areas.		
KPI	# and diversity of facilities. Level of citizen involvement. User satisfaction.		
Periodicity	On a needed basis.		

7.2.5 Actions for framework module [sm] on promoting sustainable UGS management

Action ID	[sm1]		
Action	Implement sustainable landscaping practices towards UGS sustainability and climate resilience		
Steps	Assess current UGS conditions and risks and limitations regarding their resilience to expected implications from climate change, via a collaboration with university and research centres, linking with action [se1]. Consider a phased plan for the design and adaptation of UGS based on foreseeable middle- and long-term expected conditions, e.g., average temperature increase, increase in urban population, ageing population, increase in vegetation heat stress, decrease in water availability. Consider the use of native species resistant to stress derived from heat and drought episodes in UGS establishment and / or adaptation. Set intermediate goals for, e.g., heat-island / air temperature reduction, water consumption, tree ageing index. Set intervention priorities and find adequate funds. Implement measure.		
Outcomes	The measure will contribute to resilience to climate change effects and to overall increase in sustainability.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) environmental planning and management.	Municipal departments of: (1) environment and sustainability, (2) urban management
Stakeholders	MRU / Vilnius University, local NGOs, local communities, private companies.	University of Porto, local NGOs, local communities, private companies.	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities, private companies.
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO2.5 Sustainable water + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	# of planted native trees. % of surviving trees. Change in air temperature in a set of UGS areas and control points. water consumption. Tree ageing index.		
Periodicity	On a needed basis.		

Action ID	[sm2]		
Action	Promote community involvement through volunteer programs, citizen science initiatives, and participatory decision-making processes		
Steps	Assess current situation regarding community participation and involvement on UGS design and management. Linked to section [se], define and promote community involvement actions in coordination with actions from sections [ej], [eu], [sm], and [me]. These include, e.g., [sm2], [eu1]. Promote, in partnership with local universities, citizen science projects to assess UGS quality, ecosystem disservices, maintenance issues. Promote, with local NGOs and local communities, volunteer programs for the maintenance and watering of selected UGS / UGS areas, providing, in exchange, advantages for the use of municipal sport and cultural facilities. Promote, in partnership with local universities, participatory processes for the design of new UGS.		
Outcomes	The measure will improve distributional, procedural, and recognitional equity, also promoting public civic participation.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning, (2) culture, sports, and tourism.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) environmental planning and management.	Municipal departments of: (1) environment and sustainability, (2) urban management
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.2 Reaping the benefits of digitization + SO5.1 Integrated development in urban areas.		
KPI	# of citizen science initiatives. # of citizens involved in citizen science initiatives. # of stakeholders involved in decision-making processes. # of participatory processes.		
Periodicity	Annual		

Action ID	[sm4]		
Action	**Implement NbS in the design of UGS to substitute grey solutions**		
Steps	In cooperation with universities, research centres, and private companies, several assessments should be made: (i) most common grey solutions used in the municipality by the different services involved in urban and infrastructure planning and management, (ii) NbS alternatives for all the grey solutions identified in previous step, (iii) common issues in urban planning and infrastructure development which can emerge during a UGS project, (iv) environmental monetary and non-monetary benefits from NbS, including ES provision and well-being benefits, (v) implementation and maintenance costs, covering materials, manpower, social costs and benefits, for the different alternatives NbS vs. grey solution. Assess possible funding sources benefiting NbS over grey solutions Based on steps 1 and 2, prepare a user guide for the identification of practical and viable NbS alternatives for each grey solution, indicating advantages and disadvantages for each case. Enforce NbS default use in new urban and infrastructure projects, whenever their costs and benefits, including non-monetary benefits, outweigh a specific threshold defined by the municipality.		
Outcomes	The measure will contribute towards well-being benefits, resilience to climate change effects, and sustainability goals.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning, (2) land management, (3) infrastructure development. .	Municipal departments of: (1) urban planning, (2) urban management, (3) studies and urban projects, (4) environmental planning and management, (5) green spaces and infrastructure management, (6) public space.	Municipal departments of: (1) strategic studies, planning and territorial development, (2) urban management, (3) mobility, transit and transportation, (4) environment and sustainability.
Stakeholders	MRU / Vilnius University, local NGOs, private companies	University of Porto, local NGOs, private companies	University of Coimbra / Coimbra Polytechnic University, local NGOs, private companies
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.3 Growth and competitiveness of SMEs + SO2.4 Climate change adaptation + SO2.5 Sustainable water + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	# of NbS projects implemented, % of NbS projects specifically considering biological diversity, Investment value. Comparative cost savings. # of greywater projects. Greywater volume, Greywater irrigated area.		
Periodicity	Annual		

Action ID	[sm5]		
Action	**Develop good-practice guides for the sustainable design and management of UGS**		
Steps	Assess current design and management practices related to UGS and NbS integration. Based on results from step 1, and in line with results from action [sm4], define a good practice guide for climate-change adaption for the design, renovation, and management of UGS. This guide should include, e.g., (i) incorporation of water features, considering safety precautions and water-saving measures, (ii) design options that reduce maintenance cost, e.g., using native species with low water needs, (iii) design features that can act as NbS, (iv) identification of KPI for the evaluation of results.		
Outcomes	The measure will contribute towards well-being benefits, resilience to climate change effects, and sustainability goals.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	Municipal departments of: (1) architecture and spatial planning, (2) social services for family and children.	Municipal departments of: (1) green spaces and infrastructure management, (2) studies and urban projects, (3) public space, (4) social cohesion.	Municipal departments of: (1) environment and sustainability, (2) mobility, transit and transportation, (3) social action and housing.
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.2 Reaping the benefits of digitization + SO2.4 Climate change adaptation + SO2.5 Sustainable water + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	Edition of the guide. # of mentions to the guide on new projects. Cost assessments by maintenance measure. Water consumption per usage, # of NbS solutions integrated.		
Periodicity	Annual		

7.2.6 Actions for framework module [fr] on funding and mobilization of resources

Action ID	[fr2]		
Action	**Seek partnerships with private sector stakeholders, NGOs, and research institutions, for funds and expertise.**		
Steps	Coordinate with action [se1] from section [se]. Consider creating partnerships with partners experienced in funding assessment and application. Look for knowledgeable partners in areas such as NbS, sustainability, and public participation, engaging in a two-way collaboration. Prepare a list of potential partners, with relevant contacts, areas of expertise, and potential areas for collaboration. Keep the list updated. When preparing actions for other sections, always consult the list from step 4.		
Outcomes	The measure will support stakeholder involvement, as well as increasing the chances for successful funding.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	All municipal departments.		
Stakeholders	MRU / Vilnius University, local NGOs, private companies, local communities	University of Porto, local NGOs, private companies, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, private companies local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.3 Growth and competitiveness of SMEs + SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO2.8 Sustainable urban mobility + SO4.2 Education and training infrastructure + SO5.1 Integrated development in urban areas.		
KPI	# of partnerships. # of successful partnerships (leading to concrete actions contributing towards sustainable development)		
Periodicity	Annual		

Action ID	[fr3]		
Action	Prioritize investments based on cost-effectiveness, positive social impact, and sustainability goals		
Steps	Set a relevance/priority ranking system for the different actions in all sections, based on (i) cost-effectiveness, (ii) social impacts, (iii) environmental impacts, (iv) economic impacts, and (iv) relevance for sustainability goals. Involve different stakeholders in defining the relevance values attributed to each element of the ranking system, so that this system reflects overall preferences/priorities. This will ensure less conflicts when defining priorities for investment. Collect information from all actions associated to the other actions and organize them according to the ranking system set up in step 1. Calendarize investments based on the ranking system and available funding and human resources.		
Outcomes	The measure will improve distributional, procedural, and recognitional equity, also promoting public civic participation.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	All Municipal departments.		
Stakeholders	MRU / Vilnius University, local NGOs, private companies, local communities	University of Porto, local NGOs, private companies, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, private companies, local communities
Funding opportunities	Funds: internal funds.		
KPI	# of projects vs. investment. Average investment cost per goal achieved.		
Periodicity	Annual		

7.2.7 Actions for framework module [me] on monitoring and evaluation

Action ID	[me1]
Action	**Establish key performance indicators (KPI) to track progress towards established goals and user satisfaction**
Steps	With the contribution of all municipal departments and external stakeholders, assess available information for the identification of relevant, feasible, and accurate KPI to assess the effectiveness of all different actions. Start with the proposed KPI in this framework and adjust whenever needed. When introducing changes in assessed KPI, make sure that at least one indicator per action is kept from one stage to the next, so that a minimum comparison is achievable. Assess and review results on a regular basis, to ensure an effective and practical evaluation.

Outcomes	The measure will ensure an adequate evaluation of the different actions, promoting sustainable development.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	All Municipal departments.		
Stakeholders	MRU / Vilnius University, local NGOs, local communities	University of Porto, local NGOs, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.3 Growth and competitiveness of SMEs + SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	# of KPI providing relevant information Stability of KPI per action (no changes in 'x' years).		
Periodicity	Semestral		

Action ID	[me2]		
Action	Conduct regular monitoring and evaluation of implemented interventions		
Steps	Assess accessibility needs and constrains in available UGS, Based on results from step 1, provide wheelchair accessibility to assessed UGS and ensure a minimum area inside the UGS where people with disabilities can interact with nature without physical constrains.		
Outcomes	The measure will improve environmental and distributional justice through the provision of easier access to disadvantaged populations.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	All Municipal departments.		
Stakeholders	MRU / Vilnius University, local NGOs, private companies, local communities	University of Porto, local NGOs, private companies, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, private companies, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO1.3 Growth and competitiveness of SMEs + SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	Frequency of monitoring. Discrepancies between expected and actual delivery dates.		
Periodicity	Semestral		

Action ID	[me3]		
Action	**Use stakeholder feedback and regular data collection to check for necessary adjustments and future actions**		
Steps	In line with previous action [me2]. Assess goal achievement and KPI effectiveness, to identify necessary adjustments in KPI definition and measuring.		
Outcomes	The measure will improve environmental and distributional justice through the provision of easier access to disadvantaged populations.		
Case studies	□ Vilnius	□ Porto	□ Coimbra
Responsible	All Municipal departments.		
Stakeholders	MRU / Vilnius University, local NGOs, private companies, local communities	University of Porto, local NGOs, private companies, local communities	University of Coimbra / Coimbra Polytechnic University, local NGOs, private companies, local communities
Funding opportunities	Funds: EIT, EIB, ERDF, ERC, ESF+, ESIF, Horizon Europe, LIFE, UIA. Under specific objectives SO2.4 Climate change adaptation + SO2.7 Nature protection and biodiversity + SO5.1 Integrated development in urban areas.		
KPI	# and evolution of complaints for restricted access to UGS # and evolution of accessibility measures implemented # and evolution of percentage of UGS with friendly-access interventions		
Periodicity	Semestral		

8. CONCLUSIONS

The management of UGS needs to balance social, environmental, and economic objectives while maximizing the provision of ES. In a fast-paced, ever-changing world, these challenges imply a critical need for reliable, detailed, and substantial data to inform complex managerial decisions. These data include field- and survey-based data, related to citizens' needs and expectations as well as to climate- and weather-related conditions influencing UGS usage. This is particularly relevant for decisions impacting on distributional justice.

The work developed for this dissertation involved a multidisciplinary approach oriented towards the definition of a data-based framework for the management of UGS. This framework is focused on addressing fundamental aspects such as regular, detailed, and efficient data collection, accessibility and environmental justice, community engagement, sustainable UGS management, climate change resilience and adaptation in the design of UGS, and funding resources. The framework also integrates suggestions on data collection to address usual limitations in economic and human resources.

The initial assessment regarding data collection methods allowed to identify – and create – valid and reliable methods, which form the backbone of the framework. The framework is composed of seven modules: [dc] data collection, [se] stakeholder engagement and collaboration, [ej] promoting accessibility and environmental justice, [eu] enhancing UGS infrastructure and facilities, [sm] promoting sustainable UGS management, [fr] funding and resources mobilization, and [me] monitoring and evaluation. The data collection module is the backbone of the framework.

The framework is designed for flexibility towards its application in different urban conditions, framed under community engagement, equity, and sustainability. The bottom-up approach considers UGS user preferences, motivations, and well-being benefits, as well as climate- and weather-related information, as the basis for the definition of the scope and results of proposed actions. Considering that actions are adjusted according to the data gathered, its application is flexible in the sense that inputs from the data collection module informing the framework reflect the local conditions and characteristics.

Under each module, key actions were identified to implement a sustainable and equitable management of UGS, integrated within the broader municipal scenario.

Each action description includes expected outcomes, applicability to each case study, responsible municipal actors, and potential stakeholders. Given that each city has a set of unique municipal departments and local stakeholders, this assessment will have to be adjusted for other cities. The involvement of multiple agents at the municipal level contributes towards the implementation of a common green vision, as defended in action [se2], under section [se], on stakeholder engagement and collaboration.

Funding, one of the critical aspects for the effective implementation of management measures, was also addressed, under a European context, highlighting the

current most relevant funding programs and associated objectives under which proposals can be submitted. Finally, considering the need to evaluate the effectiveness and implications of the implementation of these measures, a set of key performance indicators (KPI) were proposed, while also stressing the need to evaluate and review this list, adjusting it to the local conditions.

Regarding the specificities of each assessed case study, although the framework is flexible enough to be efficiently adapted to different situations, specific areas of improvement for each city were also identified. There is a need for a more efficient public transport network in both Vilnius and Coimbra to improve accessibility to UGS. Although the overall coverage of UGS in Vilnius is much higher than for Coimbra, Vilnius needs to consider integrating UGS as specific destinations for bus lines. Coimbra also needs changes in its public transport network and a deep investment in implementing a wider and more efficient UGS network. These suggestions are addressed in the framework, under module [ej], on promoting accessibility and environmental justice, particularly with action [ej2], aiming at improving UGS accessibility via public transport.

Regarding Porto, the assessed park showed issues related to distributional justice, which were expected to some extent due to its large size and location on the city's western limits. Under our perspective, we strongly believe that further investments need to be considered, both in Coimbra and Porto, regarding the introduction of a connected network of small UGS, which can provide equitable access to multifunctional UGS. These suggestions are considered in the framework, under module [ej] on the promotion of accessibility and environmental justice, and module [eu], on the enhancement of UGS infrastructure and facilities. For the [ej] module we can highlight actions [ej3], on implementing a network of non-motorized access to the UGS network, and [ej4], on the creation of new UGS in underserved neighbourhoods. As for the [eu] module, action [eu2] fosters the integration of universal design principles to promote inclusivity.

Concerning funding opportunities, based on our assessment for the 2021-2027 period, we suggest a diversification of fund submission in the Lithuanian case, regarding intervention fields under SO5.1 of the EU PO5 – Europe Closer to Citizens (Table 5, section 3.1.1.). In the Portuguese case, a stronger investment should be made on social equity, similar to the Lithuanian case. These suggestions are considered in the framework, under section [fr] on funding and resources mobilisation.

We believe this to be an efficient, realistic, and innovative framework towards achieving sustainable and equitable management of UGS, at least under an European context.

9. DEFENCE STATEMENTS OF THE DISSERTATION

The management of UGS requires balancing social, environmental, and economic objectives while maximizing the provision of ES.

Sustainable, balanced, and equitable UGS management needs reliable, detailed, and substantial ground-truth data to inform complex managerial decisions.

The use of a diverse set of data collection methods allows for the assessment of multiple variables related to citizens' preferences and expectations and to climate—and weather-related conditions influencing UGS usage.

A new and innovative data-based framework for GIS management is proposed. Its structure is based on a data-gathering module, which provides regular, detailed, and efficient data to support effective management decisions and actions.

The data-based framework is organized into specific modules addressing key subjects found relevant for efficient UGS management, namely (1) data collection, (2) stakeholder engagement and collaboration, (3) promoting accessibility and environmental justice, (4) enhancing UGS infrastructure and facilities, (5) promoting sustainable UGS management, (6) funding and resources mobilization, and (7) monitoring and evaluation.

The framework is designed for flexibility in its application in different urban conditions, framed under community engagement, equity, and sustainability. The bottom-up approach considers UGS user preferences, motivations, and well-being benefits, as well as climate—and weather-related information, as the basis for defining the scope and results of proposed actions.

10. FUTURE DIRECTIONS

We intend to assess the feasibility of using the collected information to develop a multi-criteria model that will support the calculation of CES availability in the area of influence of UGS and respective well-being benefits, which will be analysed as an integrated research and assessment methodology. Further work also considers the integration and analysis of other types of green infrastructure, such as horticulture gardens.

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STUDY 1: ECOSYSTEM SERVICES AND WELL-BEING DIMENSIONS RELATED TO URBAN GREEN SPACES – A SYSTEMATIC REVIEW

Pinto, L.V., Inácio, M., Ferreira, C.S.S., Ferreira, A.D., Pereira, P. (2022b). Ecosystem services and well-being dimensions related to urban green spaces – A systematic review. *Sustainable Cities and Society* 85, 104072. https://doi.org/10.1016/j.scs.2022.104072

STUDY 2: GREEN AND BLUE INFRASTRUCTURE (GBI) AND URBAN NATURE-BASED SOLUTIONS (NBS) CONTRIBUTION TO HUMAN AND ECOLOGICAL WELLBEING AND HEALTH

Pinto, L.V., Inácio, M., Pereira, P. (2023a). Green and Blue Infrastructure (GBI) and Urban Nature-based Solutions (NbS) contribution to human and ecological wellbeing and health. *Oxford Open Infrastructure and Health* ouad004. https://doi.org/10.1093/ooih/ouad004

STUDY 3: URBAN GREEN SPACES ACCESSIBILITY IN TWO EUROPEAN CITIES: VILNIUS (LITHUANIA) AND COIMBRA (PORTUGAL)

Pinto, L.V., Ferreira, C.S.S., Inácio, M., Pereira, P. (2022a). Urban green spaces accessibility in two European cities: Vilnius (Lithuania) and Coimbra (Portugal). *Geography and Sustainability*. https://doi.org/10.1016/j.geosus.2022.03.001

STUDY 4: ENVIRONMENTAL AND SOCIOECONOMIC FACTORS INFLUENCING THE USE OF URBAN GREEN SPACES IN COIMBRA (PORTUGAL)

Pinto, L., Ferreira, C.S.S., Pereira, P. (2021). Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal). *Science of The Total Environment* 792, 148293. https://doi.org/10.1016/j.scitotenv.2021.148293

STUDY 5: FACTORS AFFECTING CULTURAL ECOSYSTEM SERVICES USE IN VILNIUS (LITHUANIA): A PARTICIPATORY MAPPING SURVEY APPROACH

Pinto, L. V., Inácio, M., Bogdzevič, K., Kalinauskas, M., Gomes, E., Pereira, P. (2023b). Factors affecting cultural ecosystem services use in Vilnius (Lithuania): A participatory mapping survey approach. Heliyon, e15384. https://doi.org/10.1016/j.heliyon.2023.e15384

STUDY 6: OBSERVATION-BASED DATA-GATHERING METHOD TO SUPPORT THE ASSESSMENT OF THE USE OF CULTURAL ECOSYSTEM SERVICES IN URBAN GREEN SPACES

Valença Pinto, L., Inácio, M., Pereira, P. (2023c). Observation-based data-gathering method to support the assessment of the use of cultural ecosystem services in urban green spaces. *MethodsX 11*, 102326. https://doi.org/10.1016/j.mex.2023.102326

STUDY 7: TEMPORAL AND SPATIAL DIFFERENCES IN HUMAN ACTIVITIES PERFORMED IN URBAN GREEN SPACES OF VILNIUS (LITHUANIA)

Pinto, L.V., Ferreira, C.S.S., Pereira, P. (2024). Temporal and spatial differences in human activities performed in urban green spaces of Vilnius (Lithuania). Geogr. Sustainability. S2666683924000245. https://doi.org/10.1016/j.geosus.2024.03.002.

STUDY 8: RELEVANT LANDSCAPE COMPONENTS IN A LARGE URBAN GREEN SPACE IN OPORTO (PORTUGAL)

Valença Pinto, L., Pereira, P. (2024). Relevant landscape components in a large urban green space in Oporto (Portugal). Submitted to *Urban Forestry and Urban Greening*. https://doi.org/10.1016/j.ufug.2024.128421.

ABOUT THE AUTHOR

Luís Valença Pinto. I started working in scientific research in 1994, after finishing my degree in 'Urban and Regional Planning' (University of Aveiro, Portugal), where I learned the importance of planning and integrating nature into cities and into people's lives. As a research assistant at the University of Aveiro from 1994 to 1999, I worked in projects related to coastal management, natural and cultural heritage protection and management, environmental impact assessment, and environmental design. I got my MSc in 'Urban Environment Project' (University of Porto) in 1999, gaining a deeper understanding on sustainable development and on the challenges faced by countries, regions, and cities towards its implementation, particularly focusing on the local level. Further participation in scientific research on different projects allowed me to acquire knowledge in areas such as the development of future scenarios of land use change, land-use change models, and public participation in the decision processes and, later, on Urban Green and Blue Infrastructures (UGBI), Nature-based Solutions (NbS), and Ecosystem Services (ES), leading me to a particular interest for the relations between urban inhabitants, their use of urban green spaces, and how the later could contribute towards their wellbeing.

During the pre-PhD period of more than 25 years, I gained a solid background on the analysis and management of spatial data, having worked daily with spatial data on both research and corporate environments. I also gained a strong and valuable knowledge regarding visual communication, which I have always tried to apply in the presentation of my research results.

During my PhD I have used this accumulated knowledge on the implementation of both field work and science communication. Under my PhD I have grown a deeper knowledge on statistical analysis, face-to-face and observation surveys, while improving my critical thinking regarding the complex relations between economic, social, and environmental development, and their inherent conflicts.

ANNEXES

ANNEX 1 – List of original publications

1. Pinto, L.V., Inácio, M., Ferreira, C.S.S., Ferreira, A.D., Pereira, P. (2022). Ecosystem services and well-being dimensions related to urban green spaces – A systematic review. *Sustainable Cities and Society* 85, 104072. https://doi.org/10.1016/j.scs.2022.104072 (**IF: 11.7**).
2. Pinto, L.V., Inácio, M., Pereira, P. (2023). Green and Blue Infrastructure (GBI) and Urban Nature-based Solutions (NbS) contribution to human and ecological well-being and health. *Oxford Open Infrastructure and Health* ouad004. https://doi.org/10.1093/ooih/ouad004.
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ANNEX 2 - Scientific approvals

The results of this thesis were presented in 6 international conferences and 3 regional seminars.

1. EGU General Assembly 2021. 19-30 April 2021. Vienna, Austria.
2. 1st International Conference on Water Energy Food and Sustainability (ICoWEFS´2021). 10-12 May 2021. Leiria, Portugal.
3. Climan Study Visit II. 27-28 September 2021. Vilnius, Lithuania.
4. 3rd ESP Africa Conference. 8-10 June 2022. Musanze, Rwanda.
5. 1º Encontro de Doutorandos e Pós-Doutorados do CERNAS. July 2022. Coimbra, Portugal.
6. Climan Study Visit III. 4-8 September 2022. Vilnius, Lithuania.
7. 4th ESP Europe Conference. 10-14 October 2022. Heraklion, Greece.
8. XVI International Scientific Conference "Monitoring of Geological Processes and Ecological Condition of the Environment" (Monitoring'2022). 15-18 November 2022. Kiev, Ukraine.
9. EGU General Assembly 2023. 24-28 April 2023. Vienna, Austria.

ANNEX 3 – Bibliographic review on limitations regarding the management of UGS

A bibliographic review was done regarding the limitations associated to the management of UGS and relevant measures which can address the highlighted issues under a management framework. Table A1 shows a detailed description of all assessed documents.

Table A1 – Bibliographic analysis on implications and limitations for the management of urban green spaces and potential measures to address them under a management framework

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Aly and Dimitrijevic (2022)	The main limitations for the management of urban green spaces include limited financial resources, reduced budgets, and loss of skilled staff in many countries. Additionally, there is a lack of overarching and holistic approaches, clear visions, and strategic goals in public space management. The focus on day-to-day operational activities like maintenance and cleaning often overshadows long-term planning and strategic management. Inadequate management practices can hinder the realization of the multiple benefits urban green spaces offer to people's quality of life. Issues such as over-management leading to commodification and homogenization, as well as under-management, can threaten the identity and accessibility of public spaces. Shifting towards more innovative and comprehensive management frameworks is essential to address these challenges and ensure the sustainability and effectiveness of urban green spaces.	Context-Responsive Management: Tailoring management strategies to the specific characteristics and needs of each urban green space, considering factors like location, user demographics, and environmental conditions. Setting Direction: Establishing clear goals, visions, and strategic plans for the sustainable development and maintenance of urban green spaces, aligning them with broader urban planning objectives. Managing Performance: Implementing monitoring and evaluation mechanisms to assess the effectiveness of management strategies, track progress towards goals, and make data-driven decisions for continuous improvement. Resource Allocation: Ensuring adequate allocation of human, technical, and financial resources to support the maintenance, enhancement, and long-term sustainability of urban green spaces.
Brown and Fagerholm (2015)	The main issues for the management of urban green spaces include challenges in integrating mapped ecosystem data into decision support systems for land use planning, difficulties in engaging diverse stakeholders in participatory mapping, and the need for long-term commitment and resources to see tangible outcomes in land use decision-making.	Concrete measures for a management framework for urban green spaces could include developing specific guidelines for best mapping practices tailored to different contexts, implementing participatory mapping methods that capture ecosystem service supply and demand, and utilizing complex modeling approaches to influence decision-making processes effectively.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
CABE (2010)	Unified Management and Maintenance: The main management issue highlighted is the importance of unifying management and day-to-day maintenance functions within green space services. Separating these functions can lead to competing priorities, communication failures, and reinforce silo mentalities, making it harder to deliver quality and efficient services. Leadership and Advocacy: Strong and motivational leadership is identified as a critical driver of high-performing green space services. Effective leadership provides advocacy, vision, and ambition for the service, secures funding, builds partnerships, and drives innovation. Transparent Service Structures: Transparent and legible service structures are essential for effective service delivery. Placing green space managers close to senior management encourages better communication and coordination, while unclear structures can lead to buried services and user confusion.	Benchmarking Services: Implementing benchmarking against other services helps in assessing the quality of urban green spaces and setting clear aspirations for future improvements. Self-Assessment Tools: Utilizing self-assessment tools like TAES enables green space managers to evaluate their services, identify areas for improvement, and track progress in achieving goals. Community Engagement: Engaging with local communities and capturing their views through tools like Spaceshaper helps in understanding and meeting the diverse needs of residents, ensuring that urban green spaces are designed and managed effectively.
Costadone and Vierikko (2023)	Implications for urban green-space management include enhancing urban resilience, mitigating biodiversity loss, and improving quality of life. Limitations involve competition with other urban land uses, constraints in human and financial resources, and challenges in coordinating stakeholders with varying priorities. Implementing effective urban greening plans requires addressing these limitations to achieve sustainable and livable urban environments.	Under a management framework for urban green spaces, proposed measures include integrating green infrastructures into city master plans, implementing green participatory budgeting, and securing funding from EU programs like the LIFE Programme and Horizon 2020. Cities can also explore successful examples of local-level actions to protect biodiversity and promote urban greening, as well as consider setting qualitative or quantitative targets aligned with national and European environmental policies. These measures aim to enhance urban sustainability and livability through effective urban green-space management.
Daniels et al. (2018)	Lack of a multidimensional assessment approach for urban green spaces. Discrepancies in evaluating structural elements. Insufficient consideration of citizen perspectives in management and planning decisions.	Implementing a multidimensional assessment approach to evaluate urban green spaces comprehensively. Developing a holistic planning guideline based on structural element evaluations. Incorporating citizen perspectives into management and planning decisions for urban green spaces.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Davies, and Lafortezza (2017)	The main implications for the management of urban green spaces include the need for a more transdisciplinary approach to merge grey and green infrastructure, emphasizing connectivity and multifunctionality. However, limitations arise from the under-representation of integration and multi-scale approaches, hindering full UGI compliance. Future management strategies should focus on balancing conservation with restoration and creation of urban greenspaces to enhance connectivity and overall quality.	Concrete measures under a management framework for urban green spaces could include implementing transdisciplinary collaboration between municipal and private sectors to merge grey and green infrastructure effectively. Additionally, enhancing integration and multi-scale approaches alongside connectivity and multifunctionality to achieve full UGI compliance is crucial. Prioritizing restoration and creation of urban greenspaces alongside conservation efforts can significantly improve connectivity and overall quality of urban green infrastructure networks.
Dennis and James (2016)	Lack of detailed appraisals of the productivity of green spaces due to reliance on secondary datasets. Limited natural resources in urban areas impacting human and environmental health. Challenges in valuing urban green spaces due to their diverse functions, uses, and management practices.	Conduct detailed assessments of green space productivity through on-the-ground evaluations. Implement integrated approaches considering social-ecological interactions for effective management. Develop valuation methodologies that account for the multi-functional nature of urban green spaces.
Feltynowski et al. (2018)	Data Availability and Collaboration: Improved data availability and collaboration among stakeholders are essential for comprehensive urban green space planning and management. Broadening the definition of green spaces to include 'biologically active areas' can enhance ecosystem services delivery. Understanding the spatial distribution of various green space types is crucial for effective urban planning and ensuring accessibility. lack of comprehensive inventory data on urban green spaces, inconsistent classifications among datasets and cities, and the neglect of certain green space types by formal planning documents. Different stakeholders manage various green spaces, leading to fragmented management and neglect of connections between green spaces. Insufficient collaboration between institutions collecting and using data, as well as the marginalization of private and informal green spaces in urban management and planning, pose additional challenges.	Enhanced Data Collection: Implement participatory GIS and LiDAR data collection to gather detailed information on urban green spaces. Focus on measuring the accessibility of green spaces and related ecosystem services for different socio-economic groups. Consider attributes like physical accessibility, species composition, canopy cover, and volume for effective management planning. developing comprehensive urban green space datasets that incorporate information on management responsibilities and promote collaboration between stakeholders. Enhancing data compatibility between different datasets and improving the definition of urban green spaces in public statistics are essential measures. Encouraging the use of diverse data collection methods, such as satellite imagery and citizen science initiatives, can provide more accurate and comprehensive information for effective urban green space management.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Galdino et al. (2022)	Limitations identified for the management of urban green spaces include the need for proper infrastructure like benches, sports courts, and bathrooms to enhance usability and promote healthier lifestyle habits. Implications for management include the importance of popular participation in governance, the formulation of management plans, and managers' training to ensure the effective functioning of urban green spaces and maximize their benefits for the community. These measures are crucial for addressing issues such as accessibility, equity, and the provision of ecosystem services in urban areas.	Concrete measures proposed under a management framework for urban green spaces include the formulation of management plans, training for managers, and encouraging popular participation in governance. Additionally, creating suitable infrastructure such as benches, sports courts, and bathrooms, as well as providing equipment for exercising practices, can enhance the usability and attractiveness of urban green spaces. Research on popular participation in management and governance is essential to ensure the effective functioning and sustainability of urban green spaces, promoting healthier lifestyle habits and improving accessibility for the community.
Haland and van den Bosch (2015)	Consideration of Multiple Functions: Urban green space management needs to consider the multiple functions that these spaces provide, including ecological, social, and health benefits. Integration of Ecosystem Services: The ecosystem service approach can facilitate better urban green space planning by valuing the various benefits provided by green spaces and translating them into monetary terms. Enhanced Communication: Improved communication about the benefits of urban green spaces is essential for promoting their value and ensuring their preservation and proper management. Implications for urban green space management include the need to address challenges such as loss of public and private green spaces due to densification, insufficient provision of green spaces, and potential quality degradation. Limitations involve the risk of low priority for green space planning, cementing social inequalities, and uncertainty on how to maintain or enhance green space quality on private properties. These factors can lead to lower living quality, reduced biodiversity, and inadequate provision of ecosystem services in urban areas undergoing densification.	Implementation of Ecosystem Services Approach: Utilize the ecosystem services approach to quantify and manage the benefits provided by urban green spaces, ensuring their value is recognized and integrated into decision-making processes. Development of Quality Criteria: Establish qualitative objectives and standards for urban green space management to ensure that the spaces created are of high quality and meet the needs of the community. Enhanced Data Collection and Analysis: Improve data collection and analysis on existing green spaces to make informed decisions, prioritize goals, and allocate resources effectively for the management and development of urban green spaces. Concrete measures under a management framework for urban green spaces could include implementing green space planning policies that prioritize preservation and enhancement of existing green areas. Encouraging community involvement in green space maintenance and development projects to ensure sustainable management practices. Establishing regulations to protect green spaces from encroachment and degradation, and promoting the use of green infrastructure to enhance urban biodiversity and ecosystem services.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Hopkins (2021)	Prioritize protection and enhancement of biodiversity, green network connectivity, and cultural ecosystem services. Address challenges such as urban densification, ownership complexities, and green-washing. Develop tools for valuing ecosystem services, standardize definitions, and consider multifunctionality in green space management.	Protect Biodiversity: Implement habitat restoration projects, create wildlife corridors, and establish protected areas within urban green spaces. Enhance Green Infrastructure Connectivity: Develop greenways and bike paths, plant native vegetation to connect fragmented habitats, and integrate green roofs and walls into urban design. Promote Cultural Ecosystem Services: Organize community events in green spaces, incorporate art installations that highlight nature, and offer educational programs on the cultural significance of local ecosystems.
Ives et al. (2017)	The main limitations for the management of urban green spaces include the lack of understanding of how specific landscape variables influence green space values, the need for greater knowledge on applying insights to planning practice, and the challenge of transitioning from traditional standards-based planning models to participatory, needs-based approaches.	Concrete measures for a management framework for urban green spaces include conducting assessments of green space values and benefits, implementing Participatory GIS (PPGIS) for needs-based planning, collecting accurate data on social values and demographics, and integrating insights from research on human-environment interactions in urban green spaces.
Kabisch (2015)	Limitations identified for the management of urban green spaces included financial constraints at the municipal level, loss of expertise due to budget cuts, and low awareness of the benefits of green spaces among different actors. These limitations led to inadequate development and maintenance of urban green spaces, impacting the overall quality and sustainability of urban green areas.	Measures that can be implemented under a management framework for urban green spaces include increasing public awareness of the benefits of green spaces, securing sustainable funding sources for maintenance and development, and enhancing collaboration between different stakeholders involved in green space planning and management. These measures aim to improve the quality, accessibility, and sustainability of urban green spaces while addressing challenges related to governance and resource allocation.
Koprowskaa et al. (2020)	The main implications for the management of urban green spaces include the need for sustainable land-use planning to prevent urban sprawl, improve residents' quality of life, and attract newcomers. Limitations include the restricted availability of green spaces, the challenge of balancing densification with green space preservation, and the complexity of urban sprawl influenced by local context and interdependent factors.	Concrete measures that could be proposed under a management framework for urban green spaces include implementing sustainable land-use planning to prevent urban sprawl, focusing on existing green spaces and vacant land for preservation and development, and creating effective greening policies to improve residents' quality of life and attract newcomers. These measures aim to balance urban development with green space preservation, ensuring sustainable and livable urban environments.
Laatikainen et al. (2015)	The limitations for the management of urban green spaces include the lack of consideration for aquatic environments in accessibility studies, the underutilization of non-spatial approaches in accessibility research, and the need for more focus on public participation GIS to gather insights for better management practices.	Concrete measures for a management framework for urban green spaces include incorporating aquatic environments into accessibility studies, increasing the use of non-spatial approaches in accessibility research, and leveraging public participation GIS for better planning and management practices to ensure equitable access to green spaces.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Latinopoulos (2022)	The study underscores the importance of integrating citizens' preferences and concerns into urban planning processes to enhance the quality and accessibility of urban green spaces. Addressing spatial disparities in UGS availability and improving satisfaction levels with existing green spaces are crucial for promoting environmental, health, and social benefits. Utilizing spatial analysis tools and GIS can help city planners identify spatial hotspots of green space use and prioritize areas for development and enhancement to meet citizens' needs effectively.	Conducting regular surveys and engaging citizens to understand their preferences and concerns regarding urban green spaces. Implementing spatial analysis and GIS tools to assess accessibility, identify spatial disparities, and prioritize areas for development. Enhancing green space quality, connectivity, and accessibility to promote environmental, health, and social benefits for urban residents.
Lindholst et al. (2016)	The main limitations for the management of urban green spaces include resource constraints, weak political support, and increasing demands from various user groups. Additionally, there are challenges in defining what constitutes a 'good' urban green space, leading to ongoing debates and tensions between professionals, politicians, and the public. The need to accommodate a wider range of urban green space qualities valued by different stakeholders, such as climate change adaptation, city attractiveness, and public health agendas, further complicates management efforts.	Concrete measures that can be added to a management framework for urban green spaces include prioritizing effective provision of 'good green space' under resource constraints, enhancing public value management principles, and incorporating quality assessment schemes. Additionally, implementing inclusive approaches to management, considering a wider range of urban green space qualities valued by different stakeholders, and promoting sustainable practices can strengthen the management framework. It is essential to address the evolving needs of urban green spaces, such as climate change adaptation, city attractiveness, and public health agendas, to ensure effective and sustainable management.
Malik (2017)	Sustainable Development: Effective management of urban green spaces is crucial for achieving sustainable development goals by maintaining ecological balance, enhancing public health, and promoting economic growth. Community Engagement: Involving the community in green space management through participatory approaches can foster a sense of ownership, leading to better maintenance and preservation of these valuable assets. Policy Implementation: Governments need to enforce regulations and guidelines that mandate the provision and maintenance of green spaces in urban areas to ensure long-term environmental sustainability and quality of life for residents.	Asset Management: Implement asset management practices to optimize existing green spaces through inventory, legal audit, valuation, and information system development. Community-Based Initiatives: Engage the community in maintaining and caring for green spaces to ensure their sustainability and preservation. Regulatory Compliance: Enforce local regulations periodically to monitor and control the management of urban green spaces effectively and efficiently.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Mpofu (2013)	The study highlights the importance of proper management of urban green spaces to address challenges like illegal settlements and waste dumping. It emphasizes the need for a policy framework, coordination, and qualified manpower to improve green space management in Addis Ababa. Implementing these recommendations can lead to better preservation and utilization of urban green areas for the well-being of the city's residents and the environment.	Implementing a policy framework to regulate the use and preservation of urban green spaces. Enhancing coordination between government agencies, local communities, and private sectors involved in green space management. Investing in training and hiring skilled personnel to ensure efficient and sustainable management of urban green areas
Randrup et al. (2020)	Holistic Approach: Adopt a holistic approach that considers biodiversity, connectivity, and strategic green planning to ensure sustainable management of urban green spaces. User Engagement: Prioritize user engagement to understand and meet the diverse needs and preferences of citizens, enhancing the quality and usability of green spaces. Strategic Funding: Develop strategic funding mechanisms by seeking support from various departments and creatively highlighting the importance of maintenance budgets to ensure the long-term sustainability of urban green spaces.	Quality Indicators: Implement quality indicators focusing on usability, variation, and multi-functionality to capture diverse user needs and improve the overall quality of urban green spaces. Assessment of Hard Values: Develop common methods for assessing hard values, such as minimum requirements or quotas, to effectively communicate the value of urban green spaces to policymakers and secure necessary resources. Documentation and Standards: Establish documentation of green space values, create frameworks for local development of green space policies, and set standards for inventorying green space typologies to ensure consistent and effective management practices.
Raymond et al. (2016)	Lack of consideration for diverse user preferences and activity choices, leading to underutilization or mismatch of green space amenities. Inadequate spatial targeting of infrastructure based on activity and user diversity, resulting in unequal distribution of resources and potential conflicts among user groups. Insufficient integration of environmental justice elements into planning, which may lead to poor environmental quality and unpleasant experiences for certain users.	Conduct spatial assessments to identify activity and user diversity, enabling tailored planning strategies for different user groups. Implement infrastructure improvements based on diverse activity choices to enhance user experiences and reduce potential conflicts. Integrate environmental justice elements into planning to ensure equitable access to green spaces and address perceived problems effectively.
Rigolon (2016)	The main limitations in managing urban green spaces include challenges in acquiring new parkland, especially in areas with limited available land and ineffective regulations for developers to allocate land for parks. Addressing inequities in park proximity can be easier in affordable areas, but creating a network of green spaces may still be complex. Disparities in park quality and maintenance, particularly in underserved neighborhoods, pose additional obstacles that require targeted interventions to improve access and amenities.	Concrete measures for a management framework for urban green spaces could include implementing community-driven park design initiatives to ensure parks meet the specific needs of local residents. Developing partnerships with private stakeholders and non-profit organizations can help secure funding for park maintenance and improvements. Utilizing geospatial analyses to identify underserved areas and strategically allocating resources to enhance park access and quality can also be effective measures in the management framework for urban green spaces.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Rutt and Gulsrud (2016)	Lack of Equity Focus: The document highlights a primary limitation in the management of urban green spaces, which is the insufficient attention to equity in enjoyment and decision-making processes. This lack of focus on ensuring fair access and representation for all individuals can lead to social and environmental sustainability challenges. Inequities in Representation: Vulnerable and marginalized populations are often underrepresented in decision-making processes related to urban green spaces. This limitation can hinder the effective claim of green areas by these groups, threatening the social, economic, and environmental sustainability of urban development. Privatization and Access Issues: The privatization of urban green spaces and the development of private green areas with restricted access pose challenges. This trend can limit the availability of green spaces to certain populations, particularly those in need of the health benefits and ecological resilience provided by urban green spaces.	Equity-Centered Approach: Implementing policies and practices that prioritize equity in the management of urban green spaces, ensuring fair access, representation, and decision-making for all community members. Community Engagement: Encouraging active community participation in the planning, design, and management of urban green spaces to foster a sense of ownership, inclusivity, and social cohesion. Environmental Justice Integration: Incorporating an environmental justice framework into urban green space management to address inequalities, promote sustainability, and enhance the overall well-being of diverse urban populations.
Schetke et al. (2016)	Imbalance between built-up structures and green areas in Asian cities due to ineffective development and maintenance by public authorities. Overuse of green spaces driven by high demand for land for residential and commercial purposes. Influence of socio-economic conditions on the use and perception of urban green spaces. Limited accessibility to green spaces in fast-growing cities of developing countries. Challenges in matching the level of urbanization of developed economies, leading to pressure on land resources. Infrastructure problems and environmental stressors like air pollution increasing the demand for urban green spaces and healthy living conditions.	Enhanced Planning and Development: Implement effective urban planning strategies to ensure a balance between built-up structures and green areas. Allocate sufficient land for green spaces in rapidly urbanizing cities to meet the growing demand. Community Engagement and Participation: Involve local communities in the design, maintenance, and management of urban green spaces to enhance ownership and sustainability. Promote awareness and education programs to encourage responsible use and appreciation of green areas. Infrastructure Improvement: Enhance accessibility to green spaces by developing safe and well-connected pathways, playgrounds, and recreational facilities. Install security measures and adequate lighting to ensure the safety and usability of urban green spaces, especially in the evenings.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
Wang et al., (2024)	Urban green spaces play a crucial role in mitigating transportation-related heat and air pollution, offering benefits like reducing local air temperature, filtering air pollution, and improving urban resilience. However, challenges include the need for sufficient green space to combat the heat island effect caused by low transpiration, as well as the impact of factors like urban form, spatial location, and vegetation characteristics on the effectiveness of green spaces. To manage urban green spaces effectively, strategies such as afforestation, sustainable forest management, and green regeneration are essential, along with optimizing green infrastructure by utilizing existing spaces and increasing vegetation coverage in urban settings.	Urban green spaces play a crucial role in mitigating transportation-related heat and air pollution, offering benefits like reducing local air temperature, filtering air pollution, and improving urban resilience. However, challenges include the need for sufficient green space to combat the heat island effect caused by low transpiration, as well as the impact of factors like urban form, spatial location, and vegetation characteristics on the effectiveness of green spaces. To manage urban green spaces effectively, strategies such as afforestation, sustainable forest management, and green regeneration are essential, along with optimizing green infrastructure by utilizing existing spaces and increasing vegetation coverage in urban settings.
WHO (2017)	Conflict and Competition for Space: Addressed through community engagement and providing diverse functions to cater to different user groups. Safety Issues and Antisocial Behavior: Mitigated by ensuring regular maintenance, adequate lighting, and involving local residents in the upkeep of green spaces. Gentrification and Socioeconomic Changes: Managed by cooperating with urban and housing managers to prevent rent increases and distributing green space investments evenly.	Community Engagement: Involve local residents in planning, design, and maintenance to ensure green spaces meet their needs. Regular Maintenance: Implement routine upkeep to ensure safety, cleanliness, and attractiveness of urban green spaces. Equitable Distribution: Ensure fair access to green spaces for all population groups within the city to promote social inclusion and well-being.
Wolff et al. (2015)	The main limitations for the management of urban green spaces include challenges related to limited resources for maintenance and upkeep, competing land uses, and increasing urbanization leading to pressure on green areas. Additionally, lack of awareness about the importance of ecosystem services provided by urban green spaces and inadequate community engagement can hinder effective management efforts. Addressing these limitations requires sustainable funding, integrated land use planning, and active community involvement in decision-making processes.	Concrete measures for a management framework of urban green spaces include implementing sustainable funding mechanisms to ensure adequate resources for maintenance and conservation efforts. Engaging local communities through education and participation programs can foster a sense of ownership and stewardship of green areas. Furthermore, integrating ecosystem service assessments into urban planning processes can help prioritize conservation and restoration actions to enhance the overall benefits provided by urban green spaces.
Xu et al. (2022)	Implications for the management of urban green spaces include the need for standardized land use products to differentiate between public and private green zones for effective urban planning. Limitations involve financial constraints and workforce shortages that may hinder the maintenance of existing urban greenery facilities, especially in cities with shrinking green spaces and populations. Additionally, the lack of detailed knowledge on public and private green zones can impede comprehensive urban services planning and policymaking.	Proposed measures under a management framework for urban green spaces may include: Implementing standardized land use products to differentiate between public and private green zones for better planning and policymaking. Allocating sufficient financial resources and workforce to maintain and enhance urban greenery facilities, especially in areas facing population growth and shrinking green spaces. Conducting detailed assessments and monitoring of public and private green zones to ensure comprehensive urban services planning and sustainable management practices.

Study	Implications / limitations for UGS management	Possible measures to address these limitations
You (2016)	Social inequalities in access to Public Green Spaces (PGSs) due to uneven distribution within urban areas.	Implementing equitable distribution strategies to ensure fair access to Public Green Spaces (PGSs) for all urban residents.
	Lack of equal opportunity for urban residents and communities to access and utilize PGSs.	Developing policies that prioritize social justice and environmental equality in urban green space planning.
	Challenges in governance and implementation of ecosystem services in urban green space planning.	Enhancing governance structures to address challenges and promote sustainable management of urban green spaces.

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ANNEX 4 – Detailed discussion of the results from published papers

Considering scientific knowledge inputs to support the implementation of positive, effective, and overarching political and managerial measures, our results from study 1 suggest that it is fundamental to expand UGS research to areas of the globe other than European countries, the USA, or China. Increasing such assessments in South and Central America, Asia, and Central Africa is particularly relevant. These areas are not only highly populated urban areas but also areas where urban population growth is expected to be more intense, with urban areas occupying former natural blue and green areas (e.g., Monkkonen et al., 2018).

Furthermore, urban parks and gardens have been the most assessed UGS class. However, UGS comprises other classes with their role and relevance in different urban areas and regions. For example, forests and trees are essential in and around cities because of their role in carbon sequestration, air quality, flood regulation, and recreational ES supply (Nyelele & Kroll, 2020). They are relevant in less vegetated regions, particularly warmer regions, where forests and trees are critical in local temperature and humidity control (Kovats & Akhtar, 2008). Coastal mangroves are particular to specific areas of the globe. However, they are fundamental in buffering the negative effects of coastal storms, tsunamis, and cyclones while providing valuable habitats and diverse ES (Kadaverugu et al., 2021). Other green urban areas that might be considered 'abandoned', such as brownfields, are also relevant for the supply of valuable provisioning, regulating and cultural ES (e.g., Palliwoda et al., 2020).

The assessment of well-being benefits has predominantly focused on mental and physical well-being and good social relations (Study 1). Although these are essential in the urban context, with good social relations greatly contributing to mental well-being, the dimensions of freedom of choice and physical and food security are of great relevance. The latter is most relevant in the global south, while freedom of choice and both physical and food security are gaining relevance due to the trend of increasing autocratic governments (Bloom, 2020). Physical security is also relevant considering the global increase and intensification of extreme weather events (Bell et al., 2016), with particularly serious impacts in the urban context.

Concerning equity concerns, we found that the scientific research in the assessed papers focused mostly on distributional equity, failing to adequately address both procedural and recognitional equities, which are essential for sound environmental justice.

Further research should thus be directed towards studying other UGS types, in different regions across the world, addressing a wider diversity of well-being dimensions, and focusing on a broader coverage of the equity dimensions. Another relevant issue is the need to allocate more research resources to analysing governance models based on bottom-up approaches, e.g., through developing projects based on living labs and adaptive experimentation. This approach should be encouraged by national authorities, supporting a better and deeper involvement of local stakeholders to foster sustainable development towards more equitable cities.

Regarding our results from collected data, focused on a European context, several themes affecting UGS usage and their benefits for human well-being were highlighted through the work developed for this dissertation, including how UGS users perceive the different well-being dimensions, the relevance of user types and implicit equity issues, the relevance of UGS accessibility and its implications for UGS use and environmental justice, the relevance of user motivations in UGS use and of perceived disservices, the differences in seasonal use of UGS and associated implications related to climate-change effects, and how UGS elements affect their use, also impacting in equity. These results are also a fundamental part of the information used to build the data-driven framework.

We discuss these themes in the following subsections, considering our findings.

UGS characteristics and well-being benefits

Considering the different dimensions of well-being, mental and physical well-being were among the main factors linked to UGS usage, with mental – or emotional – well-being benefits suggested to be transversal to all UGS. Physical well-being, on the other hand, although highly valued, is often related to park characteristics, e.g., linked to the presence of sports equipment or associated with larger UGS, which provide more space for intense physical activity. These findings agree with results from other authors, which assessed that the perception of UGS availability positively influenced psychological well-being (e.g., Liu et al., 2019). The high relevance attributed to social well-being is also in line with results reported elsewhere showing that UGS promotes social interaction and cohesion (e.g., Peters et al., 2010; Kázmierczak, 2013; Balai Kerishnan & Maruthaveeran, 2021).

Social well-being was, in fact, a main factor in UGS usage in both Coimbra (Study 4) and Vilnius (Study 7). Although the assessment in Vilnius was done through observations, our results show that 57.8% of the observations were linked to social activities, thus attesting to the high relevance of social well-being associated with the use of UGS in Vilnius. In Coimbra, the respondents always associated the relevance attributed to social well-being benefits with the motivation for engaging in social relations. These results are in line with results from Jim and Chen (2006), which assessed that social activities have a universal appeal across different cultures.

Although less relevant, physical security was also identified by users in Coimbra. It was mostly associated with low levels of insecurity linked to the presence of unleashed dogs.

UGS accessibility and relevance for equity

Accessibility is one of the critical aspects of the equitable distribution of well-being benefits for urban populations. However, accessibility is not only measured in a linear distance to the closest UGS. Park dimension, for example, influences the distance a user is willing to travel to access the park (Rigolon, 2016). Another factor influencing

distance willingness to travel was the offer of equipment and spaces for engagement in different recreational activities. This is in line with results from studies elsewhere (Rall et al., 2017), which showed that park characteristics influence perceived benefits by the users.

Although not an exclusive factor, accessibility has been found to be fundamental in UGS use, according to both qualitative and quantitative analysis. Our quantitative results assessing accessibility in Coimbra and Vilnius showed that even though the cities have very different characteristics, public transport networks should be improved in both cases to address accessibility equity issues. Furthermore, access by bike presented accessibility values similar to access by car. Thus, investing and promoting a shared mobility approach and a shift towards the use of non-motorised access to UGS might provide multiple benefits, including contributions for (1) physical and mental well-being, (2) increased accessibility to UGS, (3) increased road safety, and (4) improvements in local air quality.

Reducing car circulation in urban areas, developing efficient public transport services, and providing efficient and extended cycleways and pathways are essential for sustainable development and improving well-being (United Nations, 2015; Kuss and Nicholas, 2022). However, there is a clear need for a serious improvement of public transport services. For example, Mouratidis et al. (2023) assessed that, while walking and biking were associated with well-being via travel satisfaction, public transport was considered stressful, mainly due to long travel times and poor quality of service.

Thus, investing in more efficient transport services and reducing private transport are key elements to meeting several global goals, such as UN SDG 3 (*Good Health and Well-being*), SDG 11 (*Sustainable Cities and Communities*), and SDG 13 (*Climate Action*) (United Nations, 2015; Ferreira et al., 2021). These goals also support environmental justice through distributional equity.

Accessibility and distance to UGS can, however, create negative impacts related to environmental justice. As mentioned in section 2.1, the proximity to UGS can influence housing prices, contributing to social exclusion and gentrification (Pearsall and Eller, 2020). Furthermore, citizens in different countries have different mobility habits (Roukouni et al., 2023). This implies that interventions and policies related to mobility must consider local specificities, which can support the definition of appropriate solutions. Roukouni et al. (2023) identified relevant characteristics for mobility, including urban context, spatial scale, size, transport function, and the role of the transportation network. Furthermore, our results support the idea that to provide more equitable access to UGS, with all the associated well-being benefits, UGS accessibility needs to be integrated into mobility. We need to implement efficient and user-friendly urban mobility systems and ensure they provide the most efficient and equitable access to the UGS network available in each city. Our accessibility assessment for Vilnius and Coimbra (Study 3) showed that accessibility to UGS by public transport is low in both cities compared to other transport modes (Figure 5). However, these have different associated issues. In the case of Vilnius, we noticed that the city needs to provide extended coverage for the local population, with more stops needed along the existing

lines, to increase UGS coverage. Even though the city provides for a high diversity of UGS, both in number and in spatial distribution, it has wide public transport coverage. In the case of Coimbra, although the number of UGS is much lower and their spatial distribution is limited, the population distribution and the bus lines' characteristics provide a more efficient coverage compared to Vilnius. Still, accessibility to UGS in Coimbra by public transport is lower than by bicycle. Thus, improvements are also needed, such as adjustments to local characteristics.

Factors influencing preferences for UGS and CES use

Our results highlight several factors influencing how UGS and associated CES are experienced. The user type is one such case, with our results for both Coimbra, Porto, and Vilnius confirming a clear link between available recreational equipment and facilities and different age groups and economic conditions, contributing to differences in USG usage. These results hint at environmental justice issues related to distributional equity associated with UGS spatial distribution and UGS characteristics, including location, dimension, design, and equipment. These UGS characteristics also influence the type of users; for example, younger male users are more prone to use UGS with sports equipment in all case studies. On the other hand, older adults prefer calmer UGS areas, and wealthier and older users are more prone to access more distant UGS. In contrast, older users with lower incomes tend to use closer UGS, even if they offer a lower diversity of equipment and lower potential for CES-related activities. These issues were identified in all three assessed cities in Portugal and Lithuania. For instance, older, wealthier adults in Coimbra showed facilitated access to UGS, like findings in studies elsewhere (Neuvonen et al., 2010; Rossi et al., 2015; Sun et al., 2019; Wen et al., 2020). Furthermore, we noticed that engagement in CES-related activities is influenced by users' characteristics and preferences, as well as the characteristics of the UGS, aligning with Hegetschweiler et al. (2017). These results suggest common global trends.

User motivations for specific benefits were major factors influencing UGS usage and preferences in Coimbra (Study 4) and Porto (Study 8). This was the case for tranquillity and a beautiful view, greatly improved by water elements, such as a river, a lake, or a fountain. Motivations were also found to be fundamental regarding recreational activities in Vilnius (Study 5). These results are aligned with results, e.g., from Bjerke et al. (2006), in Trondheim, Norway, from Dou et al. (2017) and Sun et al. (2019), regarding UGS visitors in Beijing, China, and from Ayala-Azcárraga et al. (2019), in México City, Mexico.

As mentioned in the sub-section on well-being dimensions, socialisation is found to be relevant also as a motivation, having registered a general dominance in group activities, either with children or with young adults, adults, and older adults, associated with socialisation, in all the developed surveys (Coimbra, Study 4; Vilnius, Studies 5 and 7; Porto, Study 8). These results confirm the global relevance of socialisation and its associated well-being dimension, derived from UGS use, as identified by other

authors (Veitch et al., 2006; Enssle and Kabisch, 2020; Rivera et al., 2021). This suggests a global trend regarding the value of UGS for socialisation and social well-being.

User motivations linked to preferred activities can also be linked to user types, as mentioned at this sub-section's beginning. Intense physical activities, such as playing sports (all study sites), biking (all study sites), or engaging in winter sports (Vilnius, Winter season), are usually associated with younger users, usually in groups, visiting parks to interact with other users through group sports. This is similar to results assessed, e.g., by Rivera et al. (2021). These users tend to choose parks with adequate conditions for their activities. This can include a basketball field, such as Vale das Flores Park in Coimbra or Vingis Park in Vilnius. Alternatively, an informal open space where children and young adults can play soccer, such as in the Mondego Green Park in Coimbra, in the large open areas in the Parque da Cidade Park in Porto, or the central lawn in Vingis Park in Vilnius.

Although UGS provide many positive ES (e.g., air quality regulation, local climate regulation, water purification, and physical and mental recreation), they can also include ecosystem disservices, e.g., the spread of invasive species, the presence of plagues, such as mosquitos associated to wetland areas, unsafe environments, both due to wild animals and to the presence of hideout places for potential criminal activities (e.g., Pereira and Baro, 2022), which can negatively affect mental and physical well-being and physical security. These disservices can act as negative motivations for UGS use.

While we registered good maintenance as a relevant factor in using UGS in Porto, we also found that most identified disservices in Coimbra were mainly associated with low maintenance issues, such as degraded soil or degraded facilities.

We also registered disservice issues related to dangerous animals associated with physical security linked to the presence of unleashed dogs, as mentioned in the well-being sub-section. These results align with results found elsewhere, e.g., by Lis et al. (2019) on women's perceived danger of walking paths in Poland, Latvia, Europe, and China, Asia. Or the study by Andrews and Gatersleben (2010) addressing perceptions of danger and fear.

Regarding the relevance of seasonality for UGS usage, its evaluation is complex. Different world regions register different weather and climatic conditions, greatly affecting how UGS are used and experienced worldwide. Furthermore, seasonal climate variability affects human physical resources and comfort, thus influencing behaviour and activities in outdoor spaces (Ahas et al., 2007; Hadwen et al., 2011).

Seasonal assessments showed different conditions between summer and winter for Coimbra (Valença Pinto & Pereira, 2022) and Vilnius (Study 7). The overall differences in the number of users by season are like those reported by other authors (e.g., Guan et al., 2021), with a higher number of users in summer, which can be explained by the warmer weather during summer, but also by the differences in daylight hours available in the different seasons, forcing winter visitors to adjust their schedule for visiting UGS. Although this is also noticeable in Coimbra (Pinto et al., 2021b), it is particularly relevant in the Vilnius case (Study 7). In fact, we found that seasonality affects UGS usage but doesn't forcibly correspond to lower levels of usage in certain daily periods

during Winter. For example, the afternoon timeslot registered more observations during Winter in most parks in Vilnius (Study 7). This can be at least partially explained by the previously mentioned schedule adjustment for daylight hours, 'forcing' users to visit UGS at earlier hours. While the morning timeslot shows more users during summer, the afternoon timeslot shows a different reality, similar to Yilmaz and Aşur (2020).

Our results also suggest that higher multifunctionality might be responsible for higher variations in usage level according to season and timeslot, e.g., large groups with children visiting only in Summer or users attracted by sports equipment visiting in late summer hours, still in daylight. Mu et al. (2021) mention that more equipped UGS attract more users than less equipped UGS. Although the percentage of users associated with the main groups of activities – social activities, experiential and esthetical activities, and physical activities – show dominance for social activities in Vilnius (Study 7) while physical activities dominate in Coimbra (Valença Pinto & Pereira, 2022), our assessment also identified a familiar and relevant trend in both cities, with a reduction of users engaging in social activities during Winter, while the number of users engaged in physical activities was higher during summer (Figure 9). This can be partially explained by the fact that winter conditions in certain parts of the globe can add further opportunities for active recreation (Yilmaz and Aşur, 2020), providing an extended set of potential CES, e.g., associated with the presence of snow, as it was observed in Vilnius (Study 7).

Another aspect that needs to be considered is that the expected increase in temperature during winter months due to climate change will most likely lead to levels of usage close to those currently assessed in the summer period, with this shift in climate conditions bringing added pressure to UGS.

Furthermore, as the global population gets older, which is particularly relevant in more developed regions such as Europe, we can expect further changes in the use patterns, both in time-of-day usage and in activities performed. This is valid for all three assessed study sites in Portugal and Lithuania.

Park elements impact user preferences, but simultaneously, personal preferences have a greater weight in decisions than socio-demographic variables for CES-related activities due to their relationship to user motivations (Study 5).

The relevance of park characteristics and components was mostly associated with a sense of *Comfort & security*, followed by *Landscape diversity*, *Water presence*, available *Recreational amenities*, and *Open spaces for activities*. The elements loading in *Comfort & security* registered the higher valuations of all landscape characteristics/components regarding their relevance in preferences for specific landscape units, except for the availability of *Open spaces for recreational activities*, which showed similar high evaluation. This is in line with previous studies, showing that UGS characteristics such as vegetation type and coverage and the presence of relevant landscape features, such as water elements, panoramic views and perceived tranquillity, all contribute towards well-being (e.g., Balai Kerishnan and Maruthaveeran, 2021).

Shadow areas were Vilnius's 4th most valued park characteristic (Study 7), also

identified in Coimbra (Study 4) and Porto (Study 8). Shadow areas are relevant due to their role in regulating the local climate. According to Klemm et al. (2016) a proportion of "40% sun, 20% half shade and 40% shade" should be ensured in UGS. The provision of shadow areas will also gain further relevance, considering the expected increase in both global temperatures and in the urban population looking for shadow areas (Riechers et al., 2018).

Concerning the high relevance attributed to available park facilities (e.g., garbage bins, benches, lights, water fountains) in both Coimbra and Porto, this is in line with results from other world locations, such as in Australia (Holman et al., 1996), or in the United States and Denmark (Refshauge et al., 2012). Although no face-to-face survey was conducted in Vilnius, the results from Study 7 confirm the relevance of benches for stationary activities. This might be explained by the presence of families with children searching for safe and well-equipped areas to engage in activities with children. Well-equipped areas have been found to be strong motivators for visits with children (Jansson and Persson, 2010).

The spatial distribution of observed stationary activities in both Vilnius and Oporto showed clear links between park facilities and specific groups of activities. For example, in Vilnius, children's playgrounds and surrounding open areas were prone to register activities related to activities with children. On the other hand, activities related to relaxation and landscape beauty avoided those same areas, indicating a clear usage pattern and relation between these contrasting activities.

MYKOLO ROMERIO UNIVERSITETAS

Luís Valença Pinto

DUOMENIMIS PAGRĮSTA EFEKTYVAUS MIESTO ŽALIŲJŲ ERDVIŲ VALDYMO SISTEMA – SOCIALINIŲ IR APLINKOS MOKSLŲ INDĖLIS

Mokslo daktaro disertacijos santrauka
Socialiniai mokslai, vadyba (S 003)

Vilnius, 2025

Mokslo daktaro disertacija rengta 2020-2024 metais Mykolo Romerio universitete pagal Vytauto Didžiojo universitetui su Klaipėdos universitetu, Mykolo Romerio universitetu ir Vilniaus universitetu Lietuvos Respublikos švietimo, mokslo ir sporto ministro 2019 m. vasario 22 d. įsakymu Nr. V-160 suteiktą doktorantūros teisę.

Mokslinis vadovas:
prof. dr. Paulo Pereira (Mykolo Romerio universitetas, socialiniai mokslai, vadyba, S 003).

Moksliniai konsultantai:
prof. dr. António Dinis Ferreira (CERN – Gamtos išteklių, aplinkos ir visuomenės tyrimų centras, Portugalijos Respublika);
prof. dr. Sander Jacobs (INBO – Gamtos ir miškų institutas, Belgijos Karalystė).

Mokslo daktaro disertacija ginama Vytauto Didžiojo universiteto, Klaipėdos universiteto, Mykolo Romerio universiteto ir Vilniaus universiteto Šiaulių akademijos vadybos mokslo krypties taryboje:

Pirmininkas:
prof. dr. Tadas Sudnickas (Mykolo Romerio universitetas, socialiniai mokslai, vadyba, S 003).

Nariai:
prof. dr. Ramūnas Povilanskas (Klaipėdos universitetas, gamtos mokslai, fizinė geografija, N 006);
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doc. dr. Miguel Villoslada (Rytų Suomijos universitetas, Suomijos Respublika, gamtos mokslai, ekologija ir aplinkotyra, N 012);
prof. dr. Jan Žukovskis (Vytauto Didžiojo universitetas, socialiniai mokslai, vadyba, S 003).

Mokslo daktaro disertacija bus ginama viešame Vadybos mokslo krypties tarybos posėdyje 2025 m. kovo 20 d. 14.00 val. Mykolo Romerio universitete, L-102 auditorijoje.
Adresas: Didlaukio g. 55, 08303 Vilnius.

SANTRAUKA

Tvarus miestų vystymasis visame pasaulyje patiria nuolatinį spaudimą dėl sparčiai augančio miestų gyventojų skaičiaus, taip pat dėl dažnėjančių ir intensyvėjančių klimato kaitos sukeltų ekstremalių meteorologinių reiškinių (pvz., karščio bangų ar intensyvių liūčių). Šis spaudimas taip pat jaučiamas miestų žaliosiose erdvėse (MŽE), kurias Jungtinės Tautos (JT) laiko pagrindiniais miestų tvarumo ir žmonių gerovės elementais. Jų svarba yra susijusi su jų teikiamų ekosisteminių paslaugų (EP) įvairove, prisidedant, pvz., prie vietos klimato ir vandens srautų reguliavimo (reguliavimo ekosisteminės paslaugos), aprūpinimo medžiagomis ir maistu (aprūpinimo ekosisteminės paslaugos) ir gamtinių kultūrinių paslaugų (kultūrinės ekosisteminės paslaugos) prieinamumo.

Tokiomis aplinkybėmis veiksmingas MŽE valdymas tampa vis svarbesnis. Tikslūs ir naujausi duomenys yra būtini bet kokiam efektyviam valdymo procesui. Tačiau prieiga prie aktualių, išsamių ir naudingų duomenų yra vienas iš pagrindinių klausimų, turinčių įtakos šių erdvių valdymui. Yra siūloma keletas sistemų, skirtų MŽE valdymui. Tačiau nė vienoje iš jų nenurodomi duomenų rinkimo poreikiai ir metodai, kurie padėtų priimti pagrįstus valdymo sprendimus, orientuotus į tvarų vystymąsi, paskirstymo ir dalyvavimo teisingumą bei padidintą žmonių gerovę.

Šia publikacijomis grindžiama disertacija siekiama prisidėti prie vadybos srities iš socialinių ir aplinkos mokslų perspektyvos, susijusios su tvariu MŽE valdymu. Viena iš pagrindinių šio darbo prielaidų yra supratimas, kad tikslūs ir aktualūs duomenys yra bet kokio efektyvaus valdymo proceso pagrindas. Šis indėlis grindžiamas duomenų rinkimo metodų vertinimu, daugiausia dėmesio skiriant duomenų rinkimo optimizavimui ir aktualios bei išsamios informacijos apie naudotojų nuostatas MŽE atžvilgiu ir su jomis susijusias kultūrines EP bei naudą žmonių gerovei. Šio vertinimo rezultatai buvo pagrindas siūlyti naują duomenimis pagrįstą sistemą, kuri padėtų MŽE valdymo praktikai, susijusiai su tokiomis aktualiomis temomis kaip prieinamumas ir aplinkosauginis teisingumas, bendruomenės įtraukimas, tvarumas, atsparumas klimato kaitai ir prisitaikymas prie jos bei tinkamas mokslinių tyrimų finansavimas. Kadangi sistema pagrįsta vietos duomenimis, ją galima lanksčiai pritaikyti įvairioms aplinkybėms ir vietovėms.

Atliktas darbas prisideda prie žinių apie žmogaus ir gamtos santykių sudėtingumą miesto aplinkoje gilinimo Europos kontekste, kartu skatinant daugiasektorinį požiūrį, susiejant socialinės geografijos ir vadybos mokslo sritis. Siūloma sistema suteikia viltingų ir optimistinių perspektyvų dėl Europos miestų ateities siekiant tvaraus ir teisingo MŽE valdymo.

MOKSLINIŲ PUBLIKACIJŲ SĄRAŠAS

Šią disertaciją, pagrįstą mokslinėmis publikacijomis, sudaro rankraštis ir aštuonios originalios publikacijos, visos paskelbtos tarptautiniuose mokslo leidiniuose, turinčiuose cituojamumo rodiklį *Clarivate Analytics Web of Science* (*CA WoS*) duomenų bazėse, iš kurių septynios turi poveikio koeficientą (engl. *Journal Impact Factor*, JIF), kaip nurodyta toliau pateiktame sąraše (**skliausteliuose**). Publikacijos šiame rankraštyje nurodomos, kaip publikacija 1–8. Autoriaus indėlis nurodomas skliausteliuose ir kursyvu (≈*%*).

1. Pinto, L.V., Inácio, M., Ferreira, C.S.S., Ferreira, A.D., Pereira, P. (2022). Ecosystem services and well-being dimensions related to urban green spaces – A systematic review. *Sustainable Cities and Society* 85, 104072. https://doi.org/10.1016/ j.scs.2022.104072 (**IF: 11.7**). (≈*95%*).
2. Pinto, L.V., Inácio, M., Pereira, P. (2023). Green and Blue Infrastructure (GBI) and Urban Nature-based Solutions (NbS) contribution to human and ecological wellbeing and health. *Oxford Open Infrastructure and Health* ouad004. https://doi.org/ 10.1093/ooih/ouad004. (≈*95%*).
3. Pinto, L.V., Ferreira, C.S.S., Inácio, M., Pereira, P. (2022). Urban green spaces accessibility in two European cities: Vilnius (Lithuania) and Coimbra (Portugal). *Geography and Sustainability*. https://doi.org/10.1016/j.geosus.2022.03.001 (**IF: 9.7**). (≈*80%*).
4. Pinto, L., Ferreira, C.S.S., Pereira, P. (2021). Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal). *Science of The Total Environment* 792, 148293. https://doi.org/10.1016/j.scitotenv.2021.148293 (**IF: 9.8**). (≈*95%*).
5. Valença Pinto, L., Inácio, M., Pereira, P. (2023). Observation-based data-gathering method to support the assessment of the use of cultural ecosystem services in urban green spaces. *MethodsX 11*, 102326. https://doi.org/10.1016/j.mex. 2023.102326 (**IF: 1.9**). (≈*95%*).
6. Pinto, L. V., Inácio, M., Bogdzevič, K., Kalinauskas, M., Gomes, E., & Pereira, P. (2023). Factors affecting cultural ecosystem services use in Vilnius (Lithuania): A participatory mapping survey approach. *Heliyon,* e15384. https://doi.org/10.1016/ j.heliyon.2023.e15384 (**IF: 4.0**). (≈*55%*).
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DARBO AKTUALUMAS

Miestų teritorijos visame pasaulyje susiduria su vis didesniais iššūkiais dėl miestų gyventojų skaičiaus augimo ir klimato kaitos. Pastarieji apima ekstremalių meteorologinių reiškinių reiškinių dažnėjimą ir skaičiaus didėjimą (Mishra et al., 2015; Lin et al., 2021), pvz., intensyvių liūčių epizodai, sukeliantys staigius potvynius (Güneralp et al., 2015) ir karščio bangų epizodai, sukeliantys papildomą stresą žaliosioms zonoms (Huang et al., 2019). Šie įvykiai turi didelius ekonominius ir socialinius padarinius. Socialiniai padariniai taip pat padidėjo dėl pasaulinės miesto gyventojų skaičiaus augimo tendencijos. 2006 m. pasiekėme 50 proc. pasaulio gyventojų, gyvenančių miestuose (UN- DESA, 2019 m.), o JT prognozėse numatyta, kad iki 2050 m. šis skaičius išaugs iki 68,4 proc. (UN-Habitat, 2022).

Miesto žaliosios erdvės yra pagrindiniai miesto struktūros elementai, teikiantys įvairias ekosistemines paslaugas miesto gyventojams. MŽE gali būti laikomos visos miesto teritorijos, padengtos augmenija ar vandeniu, kurios, be kita ko, gali apimti viešuosius parkus, miškus, gatvių medžius, kapines, upių pakrantes, upelius, ežerus, tvenkinius ar žaliuosius kelius (Vargas-Hernández et al., 2018). ES skirstomos į tris dideles sekcijas: aprūpinimo ES (AEP), pvz., geriamuoju vandeniu, maistu ir skaidulomis; reguliavimo (REP), pvz., potvynių, triukšmo, temperatūros ar oro kokybės reguliavimo; ir kultūrinės EP (KEP), pvz., rekreacinė ir patyriminė veikla (Haines-Young and Potschin, 2018).

Jungtinės Tautos, iškeltuose darnaus vystymosi tiksluose (DVT) pripažįsta pasaulinę MŽE svarbą tvarumui (JT, 2020 m.). Atsižvelgiant į didėjančią jų svarbą, MŽE valdymas tampa vis aktualesnis. Tačiau kaip galime užtikrinti veiksmingą MŽE valdymą, atsižvelgdami į šiuos tvarumo klausimus?

Išsamūs tyrimai buvo sutelkti į klausimus ir apribojimus, susijusius su MŽE valdymu. Tai, be kita ko, finansavimo ir išteklių trūkumas (pvz., Costadone ir Vierikko, 2023 m.), netinkamas planavimas ir valdymas (pvz., Aly ir Dimitrijevic, 2022 m.), prieinamumo ir aplinkosauginio teisingumo klausimai (pvz., Galdino et al., 2022 m.), išsamių ir aktualių duomenų, kuriais remiantis būtų galima priimti sprendimus, trūkumas (pvz., Feltinowski et al., 2018 m.), klimato kaita ir poveikis aplinkai (pvz., Lindholst et al., 2016) ir bendruomenės įsitraukimas bei dalyvavimas (pvz., Latinopoulos, 2022).

Remiantis vadybos mokslu, efektyviam valdymui reikia žinių įvairiose ir viena kitą papildančiose srityse (Zakarevičius, 2013). Kita vertus, duomenų rinkimas ir analizė visada buvo efektyvių valdymo procesų pagrindas, o vadyba, kaip mokslo disciplina, formuojama renkant duomenis iš praktinės patirties, juos analizuojant, apibendrinant ir darant objektyvias išvadas (Zakarevičiu,s 2013).

Atsižvelgiant į ankščiau išdėstytus teiginius ir į duomenų prieinamumo poveikį daugeliui kitų nustatytų apribojimų (pvz., netinkamo planavimo ir valdymo, klimato kaitos ir poveikio aplinkai arba bendruomenės įsitraukimo ir dalyvavimo), galima teigti, kad prieiga prie išsamių ir tikslių duomenų turėtų būti bet kokios MŽE valdymo sistemos pagrindas. Be to, MŽE aplinkosauginė ir socialinė svarba tvariai ir teisingai miestų teritorijų plėtrai pabrėžia itin svarbų socialinių ir aplinkos mokslų vaidmenį

teikiant aktualią informaciją šių erdvių valdymui.

MOKSLINĖ PROBLEMA

Tradicinės valdymo teorijos laikui bėgant keitėsi, pvz., piliečių vaidmuo perėjo prie labiau įgalinto dalyvavimo (Guogis et al., 2012; Mordhah, 2020; Osborne, 2010). Tačiau valdymas turi prisitaikyti prie dinamiškesnio požiūrio į žinių poreikius, susijusius su visuomeninėmis ir psichologinėmis savybėmis bei poreikiais, susijusiais su viešosios erdvės valdymu, iš naujo įvertindama jų svarbą valdymo procesui (Gifford and Sussman, 2012).

Žaliosios erdvės valdymas tapo populiarus visoje Europoje, ir remiamas politikos, mokslinių tyrimų ir piliečių (Hansen et al., 2023). Laikantis šio požiūrio atsižvelgiama į poreikį spręsti klausimus, susijusius su tvarumu, prieinamumu ir aplinkosauginiu teisingumu, bendruomenės dalyvavimu ir atsparumu klimato kaitai bei prisitaikymu prie jos.

Nepaisant to, dažnai yra neatitikimų tarp MŽE valdymo parinkčių ir naudotojų nuostatų, o kai kurių MŽE naudotojams svarbių aspektų valdymo specialistai nepastebi arba juos pervertina (Ugolini et al., 2022). Užfiksuota atvejų, kai duomenų apie žmonių suvokimą ir nuostatas, siejamas su MŽE ir susijusiomis kultūrinėmis EP, MŽE valdytojai nelaiko svarbiais (Bell et al., 2007, Sörensen et al., 2021).

Todėl reikia geresnio duomenų valdymo ir tarpdisciplininių įgūdžių, kad būtų galima interpretuoti įvairius duomenis, suderinant MŽE valdymą su faktiniais naudotojų poreikiais ir nuostatomis, bei integruoti strategijas su duomenų rinkimu (Sörensen et al., 2021, Ugolini et al., 2022).

Mokslas gali suteikti novatoriško įdirbio šioje srityje, pvz., išbandant įvairius duomenų rinkimo metodus. Tačiau iki šiol, remiantis vertinta literatūra, jokioje MŽE valdymo sistemoje nebuvo konkrečiai nustatyti duomenų poreikiai ir duomenų rinkimo metodai, susiję su naudotojų nuostatomis apie MŽE ir susijusių ES.

MOKSLINIO DARBO TIKSLAS

Šia disertacija siekiama apibrėžti naują duomenimis pagrįstą sistemą, kuri padėtų valdyti tvarias MŽE, kurios pagrindas būtų išsamus duomenų rinkimo modulis, skirtas teikti svarbią informaciją apie naudotojų nuostatas, susijusias su ES. Šiame modulyje apibrėžiami duomenų rinkimo metodai, kuriais siekiama teikti informaciją apie atitinkamus kintamuosius, susijusius su MŽE prioritetais, taikant daugiadisciplininį požiūrį, susiejantį valdymą ir socialinius bei aplinkos mokslus.

MOKSLINIO DARBO UŽDAVINIAI

Siekiant šios disertacijos tikslo, tyrimui buvo iškelti keli pagrindiniai uždaviniai, t.y.:

1. Įvertinti ir išbandyti įvairius duomenų rinkimo procesus, susijusius su socialinių ir aplinkos duomenų, susijusių su MŽE naudojimu, rinkimu ir apdorojimu.
2. Nustatyti atitinkamus socialinius ir aplinkos kintamuosius bei veiksnius, turinčius įtakos MŽE naudojimo nuostatoms, susijusioms kultūrinėms EP ir žmonių gerove.
3. Integruoti šias žinias apie duomenų rinkimo metodus ir kintamuosius, turinčius įtakos vartotojo nuostatoms, į praktinę ir veiksmingą duomenų rinkimo ir vertinimo sistemą, prisidedant prie atotrūkio tarp valdymo tikslų ir naudotojų nuostatų mažinimo.

DARBO METODOLOGIJA

Literatūros ir sisteminės apžvalgos buvo kelių metodinių žingsnių pagrindas. Jos padėjo: a) įvertinti MŽE svarbą darniam miestų vystymuisi ir b) nustatyti svarbiausius su MŽE valdymu susijusius klausimus. Jos taip pat padėjo c) atrinkti svarbius socialinius ir demografinius, aplinkos ir gerovės kintamuosius, susijusius su MŽE naudojimo ir su EP susijusios veiklos pasirinkimu, ir d) pasirinkti veiksmingus duomenų rinkimo metodus informacijai apie šiuos kintamuosius rinkti.

Renkant duomenis, susijusius su pasirinktais socialiniais-demografiniais ir aplinkos kintamaisiais, buvo naudojami keli duomenų rinkimo metodai, įskaitant tiesiogines apklausas vietoje, internetines visuomenės dalyvavimo geografinės informacinės sistemos (PPGIS) apklausas ir stebėjimo apklausas vietoje.

Surinkus duomenis, buvo naudojami kokybiniai ir kiekybiniai metodai, siekiant įvertinti skirtingų kintamųjų svarbą, taip pat nustatyti svarbius veiksnius, atsirandančius dėl sudėtingos kintamųjų sąveikos.

Ankstesnių etapų rezultatai suteikė pagrindo informacijai, pagal kurią apibrėžta duomenimis grindžiama sistema. Duomenų rinkimo metodai, taip pat atitinkami kintamieji ir iš to kylantys veiksniai padėjo sukurti duomenų rinkimo modulį, kuris yra valdymo sistemos pagrindas.

Atliekant kokybinį ir kiekybinį vertinimą gautos atitinkamos įžvalgos apie pagrindinius socialinius ir aplinkosaugos klausimus taip pat buvo įtrauktos į įvairių veiksmų modulių ir susijusių veiksmų, sudarančių valdymo sistemą, koncepciją.

Išsamus metodologijos aprašymas pateikiamas disertacijos 3.2 skyriuje.

Tarp vertintų atvejų tyrimų teritorijų yra Vilnius Lietuvoje ir Koimbra bei Oportas Portugalijoje. Visų pirma, atvejų tyrimų atranką sąlygojo geografiniai doktorantūros stipendijos, remiančios šias studijas (Portugalijos Mokslo ir technologijų fondas (FCT) tarptautinė doktorantūros stipendija ir priimančios institucijos Portugalijoje bei Lietuvoje), apribojimai.

Be šio apribojimo, atranka buvo pagrįsta disertacijai nustatytu tikslu ir uždaviniais. Siekiant išbandyti duomenų rinkimo modelius ir maksimaliai nustatyti atitinkamus kintamuosius, turinčius įtakos MŽE naudojimo nuostatoms, užuot lyginus lygiaverčius miestus, pasirinkta vertinti skirtingas realijas, atsižvelgiant į geografinių, klimato, kultūrinių, miesto ir socialinių charakteristikų įvairovę.

Pasirinktos teritorijos atspindi geografinius ir klimato kontrastus Europos ribose: Vilnius yra šiaurės rytinėje Europos riboje, o Koimbra ir Portas – pietrytinėje riboje. Jie taip pat atspindi miestų plėtros, gyventojų skaičiaus ir tankumo, ir MŽE prieinamumo įvairovę.

MOKSLINIS NAUJUMAS IR REIKŠMĖ

Pagrindinė šio tyrimo mokslinė naujovė - pasiūlyta nauja duomenimis pagrįsta tvaraus MŽE valdymo sistema, į kurią įtrauktas duomenų rinkimo modulis, specialiai sukurtas siekiant gauti svarbios informacijos apie naudotojų nuostatas, susijusias su EP. Vienas iš svarbiausių šio metodo aspektų - galimybė įvertinti ir integruoti socialines naudotojų nuostatas, susijusias su MŽE naudojimu ir susijusiomis kultūrinėmis EP bei žmonių gerove.

Daugiadisciplininis požiūris, susiejantis vadybos ir socialinių bei demografinių mokslų sritis, integruojant socialinės ir aplinkosaugos metodus ir koncepcijas, suteikia analizės ir rezultatų turtingumo.

Duomenų rinkimo modelis sukurtas taip, kad duomenimis pagrįsta valdymo sistema būtų lankstesnė ir lengviau pritaikoma, o tai padėtų priimti pagrįstus sprendimus dėl atsparių, teisingų ir daugiafunkcinių MŽE. Kadangi sistema pagrįsta vietos duomenimis, ją galima lanksčiai pritaikyti prie skirtingų realijų ir vietovių.

Sprendžiant miestų tankinimo, prisitaikymo prie klimato kaitos, finansavimo problemas, šiame darbe siūlomi konkretūs sprendimai miestų planuotojams ir politikos formuotojams.

Kita mokslinė tyrimo naujovė - sukurta speciali duomenų rinkimo metodika, pagrįsta stebėjimais. Šis metodas užtikrina greitą ir tikslų duomenų apie MŽE naudojimą rinkimą. Jo pritaikomumas įvairiuose miesto, kultūros ir geografiniuose kontekstuose suteikia politikos formuotojams ir miestų planuotojams aktualius ir išsamius duomenis, kurie skatina pasitikėjimą tyrimų rezultatų patikimumu.

Parengtas darbas padeda gilinti žinias apie sudėtingus žmogaus ir gamtos santykius urbanistinėje aplinkoje Europos kontekste, kartu skatinant daugiasektorinį požiūrį, susiejant socialinės geografijos ir vadybos mokslų sritis. Siūloma sistema suteikia optimistinių perspektyvų dėl Europos miestų ateities siekiant tvaraus ir teisingo MŽE valdymo.

PAGRINDINIAI REZULTATAI

Bibliografinė apžvalga ir įvairūs doktorantūros darbo metu parengti ir atlikti tyrimai suteikė dvejopą grįžtamąjį ryšį. Ryškiausias iš jų - gausi informacija apie MŽE naudojimo prioritetus ir su tuo susijusią EP ir naudą. Šie rezultatai buvo panaudoti kaip grįžtamasis ryšys apibrėžiant veiksmų modulius duomenimis grindžiamoje sistemoje. Toliau jie trumpai aptariami disertacijos 5.2 skirsnyje, kurpateikiamas sutrumpintas aprašymas, o 4 priede pateikiama išsami diskusija.

Mažiau pastebimas ryšys yra susijęs su įvairių metodų veiksmingumu siekiant

gauti tikslius, naudingus ir laiku pateiktus duomenis, taip pat su kintamųjų ir veiksnių tinkamumu.

Duomenų rinkimo metodai

Naudoti duomenų rinkimo metodai parodė, kad juos taikant galima surinkti platų duomenų rinkinį ir gauti svarbių įžvalgų apie MŽE valdymą. Šie metodai apėmė tiesioginius interviu (4 ir 8 publikacijos), internetines PPGIS apklausas (6 publikacija) ir stebėjimo apklausas (7 publikacija), kurie išsamiai aprašyti skirtingose publikacijose.

Įvertinus stebėjimais pagrįstus duomenų rinkimo metodus, buvo apibrėžtas naujas metodas, kuris buvo paskelbtas metodinės publikacijos forma (5 publikacija). Šis metodas buvo pritaikytas praktiškai ir pasirodė esąs labai veiksmingas siekiant sumažinti stebėjimo duomenų rinkimo laiką intensyvaus naudojimo teritorijose (7 publikacija).

Taip pat buvo nustatyta, kad MŽE prieinamumas yra svarbus jų naudotojams (pvz., 4 publikacija), kas sąlygojo paprasto metodo sukūrimą MŽE prieinamumui įvairiomis transporto rūšimis skirtinguose miestuose analizuoti (3 publikacija), vertinant iš paskirstymo teisingumo perspektyvos.

Skirtingi duomenų metodai papildo vienas kitą, nes jais galima surinkti papildomą informaciją. Jie suteikia daugybę duomenų apie naudotojų nuostatas, siejamas su ES susijusia veikla MŽE, taip pat apie suvokiamą naudą jų gerovei. Kelių duomenų šaltinių ir duomenų rinkimo metodų taikymas ypač naudingas savivaldybių lygmeniu, nes jos dažnai turi ribotus ekonominius ir žmogiškuosius išteklius (De Luca et al., 2021; Van Der Jagt et al., 2020).

Surinkti informacijos sluoksniai leidžia geriau pažinti ir suprasti naudotojų nuostatas ir naudojimosi MŽE tendencijas, o tai labai svarbu siekiant veiksmingai ir tvariai valdyti šias erdves (Latinopoulos, 2022). Jie suteikia pagrindinius etaloninius duomenis (angl. ground truth) [5], kurie yra būtini UGS valdymo sprendimų priėmimo procesams (Moller et al., 2019). Jų svarba pasireiškia tuo, kad jie prisideda prie planavimo, projektavimo ir valdymo grupių veiklos suderinimo su tikraisiais naudotojų poreikiais ir nuostatomis (Ugolini et al., 2022).

Taikomi kintamieji

Vertinant pasirinktų kintamųjų ir veiksnių svarbą, rezultatai buvo suskirstyti į tris pagrindines grupes, kurios atspindi svarbias temas, išryškėjusias vertinant kintamuosius. Jos susijusios su: 1) MŽE charakteristikomis ir nauda žmonių gerovei, 2) MŽE prieinamumu ir svarba teisingumui ir 3) veiksniais, darančiais įtaką MŽE ir KEP naudojimo nuostatoms.

Trumpai reziumuojant: a) naudotojų suvokimas apie naudą, gaunamą lankantis MŽE ir užsiimant su KEP susijusia veikla, gali padėti imtis efektyvių valdymo

5 Etaloniniai duomenys gali būti suprantami kaip informacija, kurią suteikia tiesioginis stebėjimas ir matavimai (t. y. empiriniai įrodymai), o ne informacija, kurią pateikia išvados.

veiksmų, daugiausia dėmesio skiriant saugių ir daugiafunkcių erdvių užtikrinimui; b) MŽE prieinamumas gali suteikti svarbios informacijos apie potencialius klausimus, susijusius su MŽE ir susijusios naudos žmonių gerovei paskirstymo teisingumu; c) nuostatos dėl rekreacinės įrangos (pvz, sporto, kultūrinės) gali suteikti informacijos apie galimą pasiūlos ir paklausos neatitikimą; d) nuostatos dėl parko įrangos , pavyzdžiui, pavėsio, sėdimų vietų, žaidimų aikštelių ir vandens telkinių, daro įtaką MŽE patrauklumo lygiui ir turėtų būti vertinami atsižvelgiant į jų prieinamumą ir priežiūros būklę; e) nustatyta, kad naudotojų socio-demografinės charakteristikos, pvz, amžius ir ekonominės sąlygos, turi įtakos įsitraukimui į su KEP susijusią rekreacinę veiklą; f) nustatyta, kad naudotojų motyvacija turi esminę reikšmę rekreacinei veiklai Vilniuje (5 publikacija) ir priklauso nuo parko charakteristikų, kuri yra svarbi funkciniams ir ekologinio valdymo procesams; g) su laiku susiję kintamieji, įskaitant KEP naudojimo sezoniškumą, savaitinius skirtumus ir paros laiką, turi įtakos KEP naudojimui; h) su parko kraštovaizdžio komponentais susijusios nuostatos turi įtakos naudotojų suvokimui, pvz, patogumo ir saugumo arba kraštovaizdžio įvairovės, o tai turi įtakos naudotojų pasirinkimams.

Nepaisant šių privalumų, MŽE gali turėti ir trūkumų. Saugumo problemos, invazinės rūšys ar netinkama priežiūra gali atgrasyti nuo MŽE naudojimo. Be to, gali kilti aplinkosauginio teisingumo problemų, nes MŽE kaimynystė gali turėti įtakos būsto kainoms, prisidėti prie socialinės atskirties ir gentrifikacijos. Sprendžiant šiuos iššūkius, taikant duomenimis grindžiamas valdymo sistemas, kuriose atsižvelgiama į vietos ypatumus, susijusius su prieiga prie MŽE, naudotojų demografiniais rodikliais ir parkų ypatybėmis, galima maksimaliai padidinti MŽE teikiamą naudą ir skatinti įtrauktį, remiant gerovę ir aplinkosauginį teisingumą miestų teritorijose.

Nauja duomenimis grindžiama MŽE valdymo sistema

Visi šie rezultatai padėjo parengti pasiūlytą duomenimis pagrįstą sistemą, kuria siekiama pašalinti informacijos spragas ir padidinti MŽE įtraukimą į pasaulinius miestų valdymo procesus. Siūloma sistema paremta visa apimančiu ir naujovišku duomenų rinkimo moduliu, pagrįstu atliktų tyrimų rezultatais. Šis duomenų rinkimo modulis apima MŽE fizinio prieinamumo vertinimą ir kintamųjų (apibendrintų ankščiau) gausos vertinimą naudojant įvairius duomenų rinkimo būdus. Prieinamumo vertinimas turėtų būti grindžiamas geografinės informacinės sistemos (GIS) tinklo analize įvairiems transporto būdams, įskaitant bent jau ėjimą pėsčiomis, važiavimą dviračiu ir viešąjį transportą. Renkant duomenis apie kitus kintamuosius, turėtų būti atliekamos įvairių tipų apklausos, t. y. tiesioginės apklausos, stebėjimo apklausos ir internetinės visuomenės dalyvavimo GIS apklausos (PPGIS). Šios disertacijos pagrindu buvo sukurtas specialus duomenų rinkimo metodas, pagrįstas stebėjimais (5 publikacija), orientuotas į duomenų rinkimo efektyvumą ir tikslumą. Šis metodas papildo duomenų rinkimo metodų įvairovę, taip pat etaloninius duomenis, kuriais remiasi veiksmingų sprendimų priėmimo sistema. Stebėsenos ir vertinimo modulis apima internetinę priemonę, skirtą rinkti naudotojų duomenis apie tai, kaip jie suvokia MŽE būklę ir

pasitenkinimo ja lygį.

Siūlomą duomenimis grindžiamą valdymo sistemą (schematiškai pavaizduota pagrindinės disertacijos 11 paveiksle) sudaro moduliai [dc] Duomenų rinkimas ir analizė, [se] Suinteresuotųjų šalių įtraukimas ir bendradarbiavimas, [ej] Prieinamumo ir aplinkosauginio teisingumo skatinimas, [eu] MŽE infrastruktūros ir įrenginių gerinimas, [sm] Tvaraus MŽE valdymo skatinimas, [fr] Finansavimas ir išteklių telkimas bei [me] Stebėsena ir vertinimas.

Duomenų rinkimo modulis yra sistemos pagrindas. Šiame modulyje integruoti duomenų rinkimo metodų vertinimo rezultatai. Moduliai išsamiai aprašyti pagrindinės disertacijos 7.1 skyriuje. Šioje sistemoje integruojamos duomenimis pagrįstos įžvalgos, suinteresuotųjų šalių įtraukimas ir holistinis požiūris į parko valdymą, kuriuo siekiama pagerinti MŽE kokybę, prieinamumą ir tvarumą, taip pat spręsti aplinkosauginio teisingumo klausimus. Kiekviename modulyje apibrėžiami keli pagrindiniai veiksmai, kuriais siekiama įgyvendinti tvarų ir teisingą MŽE valdymą, integruotą į platesnį savivaldybės scenarijų. Jie išsamiai aprašyti pagrindinės disertacijos 7.2 skyriuje. Nors sistema yra bendro pobūdžio, ją galima įgyvendinti vietos lygmeniu, įvertinus ir integravus vietos ypatumus, gautus iš duomenų rinkimo modulio.

Sistemoje daugiausia dėmesio skiriama tokiems pagrindiniams aspektams kaip reguliarus, išsamus ir veiksmingas duomenų rinkimas, prieinamumas ir aplinkosauginis teisingumas, bendruomenės įtraukimas, tvarus MŽE valdymas, atsparumas klimato kaitai ir prisitaikymas prie jos projektuojant MŽE bei finansavimo ištekliai.

Sistema sukurta taip, kad ją būtų galima lanksčiai taikyti įvairiomis miesto sąlygomis, atsižvelgiant į bendruomenės dalyvavimą, teisingumą ir tvarumą.

Taikant metodą „iš apačios į viršų“ atsižvelgiama į MŽE naudotojų nuostatas, motyvus ir naudą žmonių gerovei, taip pat į su klimatu ir orais susijusią informaciją, kuria remiantis apibrėžiama siūlomų veiksmų apimtis ir rezultatai. Atsižvelgiant į tai, kad veiksmai koreguojami pagal surinktus duomenis, jo taikymas yra lankstus ta prasme, kad duomenų rinkimo modulio įvestys, kuriomis grindžiama sistema, atspindi vietos sąlygas ir ypatybes.

Kiekvieno veiksmo aprašyme nurodomi laukiami rezultatai, pritaikomumas kiekvienam atvejo tyrimui, atsakingos savivaldybės šalys ir kitos galimos suinteresuotosios šalys. Atsižvelgiant į tai, kad kiekvienas miestas turi unikalių savivaldos skyrių ir vietos suinteresuotųjų šalių rinkinį, šį vertinimą reikia pritaikyti kitų miestų atvejams. Daugelio vietos savivaldos lygmens šalių dalyvavimas padeda įgyvendinti bendrą žaliąją viziją, kaip nurodoma veiksme [se2], skyriuje [se], skirtame suinteresuotųjų šalių įtraukimui ir bendradarbiavimui.

Europos kontekste taip pat buvo aptartas finansavimas - vienas iš svarbiausių aspektų, leidžiančių veiksmingai įgyvendinti valdymo priemones, - pabrėžiant šiuo metu aktualiausias finansavimo programas ir susijusius tikslus, pagal kuriuos galima teikti paraiškas. Galiausiai, atsižvelgiant į poreikį įvertinti šių priemonių įgyvendinimo veiksmingumą ir pasekmes, taip pat siūlomas pagrindinių veiklos rodiklių rinkinys, kartu pabrėžiant, kad šį sąrašą reikia vertinti ir peržiūrėti, pritaikant jį vietos sąlygoms.

GINAMIEJI TEIGINIAI

Norint valdyti MŽE, reikia suderinti socialinius, aplinkos ir ekonominius tikslus, tuo pačiu maksimaliai padidinant ekosisteminių paslaugų teikimą.

Tvariam, subalansuotam ir teisingam MŽE valdymui reikalingi patikimi, išsamūs etaloniniai duomenys, kuriais būtų galima pagrįsti sudėtingus valdymo sprendimus.

Naudojant įvairius duomenų rinkimo metodus galima įvertinti įvairius kintamuosius, susijusius su naudotojų prioritetais ir lūkesčiais, taip pat su klimatu ir oru susijusiomis sąlygomis, turinčiomis įtakos MŽE naudojimui.

Siūloma novatoriška duomenimis pagrįsta MŽE valdymo sistema, kurios struktūra būtų pagrįsta duomenų rinkimo moduliu, reguliariai teikiančiu išsamius ir veiksmingus duomenis, padedančius priimti veiksmingus valdymo sprendimus ir imtis veiksmų.

Duomenimis grindžiama sistema suskirstyta į konkrečius modulius, skirtus pagrindiniams klausimams, kurie, kaip nustatyta, yra svarbūs veiksmingam MŽE valdymui, t. y. 1) duomenų rinkimui, 2) suinteresuotųjų šalių dalyvavimui ir bendradarbiavimui, 3) prieinamumo ir aplinkosauginio teisingumo skatinimui, 4) MŽE infrastruktūros ir įrenginių gerinimui, 5) tvaraus MŽE valdymo skatinimui, 6) finansavimo ir išteklių sutelkimui ir 7) stebėsenai ir vertinimui.

Sistema sukurta taip, kad ją būtų galima lanksčiai taikyti skirtingomis miesto sąlygomis, atsižvelgiant į bendruomenės dalyvavimą, teisingumą ir tvarumą. Taikant metodą „iš apačios į viršų“, nustatant siūlomų veiksmų apimtį ir rezultatus, atsižvelgiama į MŽE naudotojų nuostatas, motyvus ir naudą žmonių gerovei, taip pat su klimatu ir orais susijusią informaciją.

Valença Pinto, Luís

A DATA-BASED FRAMEWORK FOR EFFICIENT URBAN GREEN SPACE MANAGEMENT – CONTRIBUTIONS FROM SOCIO-ENVIRONMENTAL SCIENCES: daktaro disertacija – Vilnius: Mykolo Romerio universitetas, 2025. 140 P.

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The dissertation aims to provide a critical assessment and to model a conceptual data-based framework to support sustainable UGS management grounded on a bottom-up approach, oriented towards the integration of user preferences. Accordingly, the research focused on content, trends, limitations, and innovative data collection methods and relevant variables supporting sustainable and participative UGS management frameworks. Data collection methods and variables were tested in three diverse cities in Europe: Vilnius, in Lithuania, and Oporto and Coimbra, in Portugal. This knowledge was then integrated into the conceptualisation of a new data-based framework for the sustainable management of UGS through the definition of a specific data-collection module. The multidisciplinary approach, linking management and socio-environmental science fields by integrating methods and concepts from the latter, adds richness to the analysis and results, focused on reducing the gap between management goals and user preferences. Based on local data, the framework is flexible in adapting to different realities and locations.

Disertacijos tikslas – pateikti kritinį vertinimą ir sumodeliuoti konceptualią duomenimis pagrįstą sistemą, kuri padėtų tvariai valdyti MŽE, grindžiamą principu „iš apačios į viršų“, orientuotą į naudotojų pageidavimų integravimą. Atitinkamai tyrime daugiausia dėmesio ir buvo skiriama turiniui, tendencijoms, apribojimams ir novatoriškiems duomenų rinkimo metodams bei atitinkamiems kintamiesiems, palaikantiems tvarias ir dalyvaujamąsias MŽE valdymo sistemas. Duomenų rinkimo metodai ir kintamieji buvo pritaikyti trijuose skirtinguose Europos miestuose: Vilniuje Lietuvoje ir Porto bei Koimbros miestuose Portugalijoje. Vėliau šios žinios buvo įtrauktos į naujos duomenimis pagrįstos tvaraus MŽE valdymo sistemos koncepciją, apibrėžiant konkretų duomenų rinkimo modulį. Daugiadisciplininis požiūris, susiejantis vadybos ir socialinių bei aplinkos mokslų sritis, integruojant pastarųjų metodus ir koncepcijas, suteikia analizės ir rezultatų turtingumo, orientuojantis į atotrūkio tarp valdymo tikslų ir vartotojo pageidavimų mažinimą. Remiantis vietos duomenimis, sistema lanksčiai pritaikoma prie skirtingų realijų ir vietovių.

Luís Valença Pinto

A DATA-BASED FRAMEWORK FOR EFFICIENT URBAN GREEN SPACE MANAGEMENT – CONTRIBUTIONS FROM SOCIO-ENVIRONMENTAL SCIENCES

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Socialiniai mokslai, vadyba (S 003)

Mykolo Romerio universitetas
Ateities g. 20, Vilnius
Puslapis internete www.mruni.eu
El. paštas roffice@mruni.eu
Tiražas 20 egz.

Parengė spaudai Martynas Švarcas

Spausdino UAB „Šiaulių spaustuvė“
P. Lukšio g. 9G, 76200 Šiauliai
El. p. info@dailu.lt
https://siauliuspaustuve.lt