

The 5th International Conference on Economics and Social Sciences
Fostering recovery through metaverse business modelling
June 16-17, 2022
Bucharest University of Economic Studies, Romania

**Urban Green Infrastructure, Ecosystem Services
and Challenges for Universities to Respond
to the Needs of Society**

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DOI: 10.24789788367405072-038

Abstract

Universities are more and more interested in responding to the society's needs and contributing to the sustainable development of cities. The COVID-19 pandemic challenges universities to innovate and develop more adaptive educational practices. The green urban infrastructure is designed and implemented to improve sustainability and reduce vulnerability to natural hazards. It is increasingly advocated as a win-win solution for nature and human communities. The biophysical structure of the green infrastructure generates ecological processes and functions that humans can appropriate as ecosystem services that contribute to human well-being. This paper aims to assess the students' perception of the current state and problems faced by the green infrastructure in Bucharest, the students' willingness to get involved in volunteer and service-learning activities, and their knowledge of the ecosystem services concept. We applied face-to-face questionnaires. As hypothesized, students' perceptions and knowledge of the current state and threats to the urban green infrastructure and ecosystem services depend on their professional background. However, more than 94% of the respondents consider that the current number of green spaces in Bucharest is insufficient. Even more of them (97%) believe that the level of protection of urban green spaces is inadequate. More than three-quarters of those involved in research are interested in participating in volunteer and service-learning activities. Our results could inform the university's decision-makers and stimulate innovation by allowing students to develop a deeper understanding of environmental issues, engage in problem-solving, and make informed and responsible decisions. It is for the benefit of civic universities, students, and communities alike.

Keywords: perceptions, students, civic engagement, universities, urban green infrastructure, ecosystem services.

JEL Classification: I23.

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1. Introduction

The Ecosystem Services (ESs) framework has enabled the broader public to acknowledge the benefits that nature provides to humans (Felipe-Lucia et al., 2015). According to the Common International Classification of Ecosystem Services – CICES (Haines-Young, Potschin, 2012), these include tangible or material benefits such as provisioning services (e.g., food, raw materials) and intangible benefits such as cultural services (e.g., recreation, environmental education and aesthetic enjoyment), regulating and supporting services (e.g., climate regulation, habitat provision, and soil formation). ESs have become essential for decision-making, their assessment being a support tool for urban and landscape planning to improve the quality of life (Cheng et al., 2019).

The green spaces within and around cities designed by humans or fragments of once natural-origin ecosystems, compact or discontinuous, accessible to the public or not, with or without active management, projected for recreational use or not and regardless of a specific spatial scale, are all considered urban green spaces (Swanwick et al., 2003) or urban green infrastructure – UGI (Tzoulas et al., 2007). These can be fragments of rivers crossing a city, wetlands, forests, cemeteries, gardens, parks and play areas, green roofs and walls, linear trees, shrubs or herbs around railways, and roads (Wolch et al., 2014). They can consist of various species of vegetation and have different connectivity to one another or different types of legal protection – i.e., urban protected vs. unprotected areas (Wolch et al., 2014). UGI provides a suite of ESs that are widely recognized as critical to health, well-being, and sustainability on an urbanizing planet (du Toit et al., 2018): microclimate regulation, mitigation of the urban heat island, increased air quality (Martins, 2022). UGIs represent biodiversity hotspots in cities (Attila et al., 2021) and participate in the carbon storage process (Davies et al., 2011).

A stakeholder can be defined as a “group or individual who can benefit from the ESs provision” (Haines-Young, Potschin, 2012). The involvement of stakeholders (e.g., representatives of locally affected communities, national or local government authorities, politicians, civil society organizations, and businesses) in the process of identifying the ESs provided by natural capital is an essential condition for effective governance (Felipe-Lucia et al., 2015). However, there are few specialized works in which the students are involved as beneficiaries of the ESs delivered by UGI (Lungu, Rîșnoveanu, 2021).

The societal protective measures taken during the COVID-19 pandemic were highly effective in preventing the spread of the virus (Brauner et al., 2021). However, concerning mental and physical health, social distancing posed significant risks to people of all age groups (Flanagan et al., 2021; Lades et al., 2020). These measures could have fundamentally changed the relationship between people and UGI regarding the use and perception of ESs they provide (Ugolini et al., 2020). In this context, UGI offered specific ESs for human well-being, such as the possibility of carrying out recreational and sports activities, aesthetic benefits, and growing food (Lehberger et al., 2021; Ugolini et al., 2020). A survey developed between April and July 2020 (Robinson et al., 2021) reported that more than 90% of the respondents

increased the period spent visiting UGI, such as gardens (48%), woodlands (14%), and urban parks (11%).

Previous studies have focused on the relationship between green spaces and the academic benefit of students showing a positive effect of UGI on their well-being and academic performance (Collins et al., 2022). University students are considered a vulnerable group as a matter of mental and physical health both before (Holm-Hadulla, Koutsoukou-Argyriaki, 2015; Kousis et al., 2020) and during (Browning et al., 2021) the COVID-19 pandemic.

Service-learning involves university initiatives designed to engage students in community learning and service activities as part of their regular coursework (Martin et al., 2005). Successful university-community partnerships acknowledge and incorporate the participatory efforts of the various stakeholders (Lasker et al., 2001; Martin et al., 2005).

2. Problem Statement

In recent decades and especially during the COVID-19 pandemic, people changed their exposure patterns to nature, valuing the UGI more. Universities have a social responsibility to improve the well-being of society (Dhakal, Chevalier, 2017). They may offer research opportunities and courses on UGI and its ESs (Dhakal, Chevalier, 2017), can partner with various institutions in order to train communities (Rîşnoveanu et al., 2021), advise more efficiently the policymakers (Poole, 1997) and have more initiatives on campus greening (Sima et al., 2019).

Students represent a particular category of stakeholders who can ensure the connection between the academic environment, society, decision-makers, and other stakeholders (Poole, 1997), being valuable providers of information and solutions. However, students are rarely involved in the identification and mapping of ESs (Lungu, Rîşnoveanu, 2021). Despite recognizing the role that UGI plays in cities, there is not enough awareness of ESs among stakeholders. We hypothesized that students' perceptions and knowledge of the current state and threats to the UGI and ESs relate to their professional background. Understanding patterns of perception among students with different academic backgrounds helps universities identify practical opportunities and challenges for students to apply practically the theoretical knowledge and increase their professional capacity, stimulate critical thinking, and develop skills and competencies for the benefit of civic universities, students, and communities alike.

3. Aims of the Research

The aims of our research were: i) to assess the students' perception of the current state and problems faced by the UGI in Bucharest; ii) to assess the students' willingness to get involved in volunteer and service-learning activities; iii) to assess the students' knowledge of the ESs concept.

4. Research Methods

During the COVID-19 pandemic, from 22 to 25 November 2021, within the CIVIS initiative, we were able to carry out a series of online workshops and use Google forms to apply questionnaires (for questions, see Table 1) to assess the students' perception and knowledge of the current state and threats to the UGI of Bucharest and the ESs it provides. We promoted the research through social networks of student associations and professors involved in CIVIS OpenLab initiatives. The involvement of students was voluntary, and without any restriction.

Table 1. Questions asked in the student questionnaire

No.	Question	Potential answers
1	Do you consider that more green zones are needed in/around Bucharest?	1-high need, 2-average need, 3-not a need
2	Do you think that better protection of green urban zones is needed?	1-high need, 2-average need, 3-not a need
3	Which of the following problems do you think Bucharest is facing? a) The development of road infrastructure b) Development of the real estate industry c) Climate change d) Exploitation of natural resources e) Intensive tourism f) The air pollution g) Economic activities h) The ambiguous legislative framework regarding UGI i) Non-prioritization of the social role of UGI j) Waste disposal k) The disinterest of decision-makers l) Lack of infrastructure for visiting green zones (in the case of larger green zones) m) Inadequate zonally urban planning plans n) The disinterest of the citizens o) Lack of awareness of ecosystem services p) Inconsistent application of the law q) Invasive species	1-high risk, 2-average, 3-not a problem
4	Are there other issues that Bucharest faces that have not been mentioned before?	Open question
5	Are you willing to get involved in volunteer and service-learning activities?	Yes/No
6	Do you know the concept of "ecosystem service"?	Yes/No
7	How would you define ecosystem services?	Open question

Source: Authors' own research.

Although most of the students participating in the workshops are not permanent residents of Bucharest, they benefit from the ESs offered by the UGI throughout the academic year, when they spend most of their time in the city. The research involved 174 students from six faculties of the University of Bucharest (Business and Administration, Biology, Geography, Psychology, Letters, Sociology, and Social Assistance).

To account for the different perceptions related to students' academic background, we grouped the students into four groups: life sciences (biology, ecology, geography), business and administration, social sciences (sociology, psychology, pedagogy), and philology (letters). We applied face-to-face questionnaires during four online workshops (one for each group), which included both closed and open questions. For each closed question (e.g., questions 1-3 in Table 1), students were asked to allocate weights from 1 (very important) to 3 (the least or not important).

Also, we assess the students' willingness to get involved in volunteer and service-learning activities. Considering the need to make operational the ecosystem services concept and its role in feeding the decision support system by translating complex functions and processes of ecosystems into indicators for urban planning and governance, we test how familiar the students are with this concept.

5. Findings

Our research involved 140 women and 34 men between 18 and +36 years old. Most of them (87%) are 18-25 years old. A large proportion (85%) consists of undergraduate students. Only 5% are Ph.D. students. Students' perceptions, desire to engage in volunteer activities, and their knowledge of UES do not differ by genus, age, or level of studies.

5.1 The Students' Perception of the Current State of UGI and the Problems It Faces in Bucharest

More than 94% of the respondents consider that the current number of green spaces in Bucharest is insufficient. Even more of them (98%) believe that the level of protection for UGI is inadequate and needs to be improved. These results are consistent with Badiu et al., 2016, who revealed that in the largest cities in Romania (including Bucharest), the surface of UGI is 16.82 m² per capita, 97.36% of them providing fewer green surfaces compared to national legislation.

The great majority of students consider that Bucharest faces all the issues listed under question no. 3 in Table 1. Among the issues perceived to pose a high risk to the city's development, the disinterest of decision-makers accounts for the highest score (85.71% of students in philology) and the invasive species the lowest (19.04% and 22.2% of students in philology and social sciences, respectively). There is an agreement among students in all four groups (more than 70% of respondents) that the disinterest of both decision-makers and citizens and inadequate waste disposal pose urban green spaces at high risk. The highest proportion of students in life

sciences and business and administration (more than 65%) perceive the lack of awareness of ESs and inconsistent application of the law as being issues of high importance the UGI faces. Students in life sciences and philology (more than 70%) point to the development of the real estate industry, and those in business and administration and philology (>75%) to air pollution. Students in business and administration (>65%) also allocate high weights to non-prioritization of the social role of UGI in urban planning and lack of infrastructure for visitation, and those in philology (>66%) to the exploitation of natural resources.

Students identify some supplementary issues, apart from those in Table 1. Among them, it is worth mentioning the following: lack of environmental education and limited awareness of the ESs provided by UGI (students in life sciences, business and administration), noise pollution (students in business and administration, social sciences), insufficient parking places that end up in the use of UGI for cars parking (all groups) and decrease in quality of life (students in life sciences and philology), incoherent management of synanthropic species and lack of landscape planning especially in the marginal districts (students in life sciences), too few places to spend time outdoors with kids (students in business and administration), and lack or insufficient infrastructure within UGI – e.g., toilets (students in philology).

5.2 The Students' Willingness to Involve in Civic Engagement Activities

The CIVIS initiative, a European civic universities alliance, encourages and promotes the activities that allow students' civic engagement by carrying out projects and workshops. Our results show a high interest of the students at the University of Bucharest in actively participating in the current problems of society related to the UGI through volunteer or service-learning activities. The highest interest was expressed by students in life sciences and philology (96%) and the lowest by students in social sciences (73%).

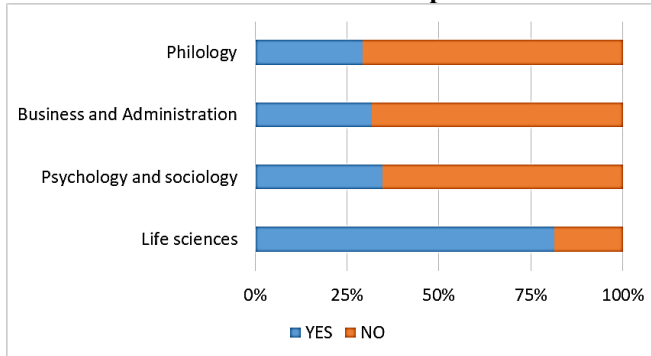
5.3 The Students' Knowledge of the ESs Concept

Less than half (48.6%) of attendees consider themselves familiar with the ESs concept. Most of them (56.5%) have a background in life sciences (biology, ecology, geography) – Figure 1. On average, more than 50% of the respondents consider ESs to be the benefits that humans receive from nature (Figure 2). While a greater proportion of students in life sciences (65%) and philology (74%) perceive ESs as benefits offered by nature, a significant proportion of students with training in social sciences (19%) and in business and administration (22%) point to the decisive role of ESs for human well-being. Between 11 and 14% of the respondents know that UGI provides direct and indirect, tangible and intangible services, excepting students in philology (Figure 2). Only one student with a background in life sciences associates ESs with the functions and processes in natural systems. Another highlights the importance of the concept in assisting the decision-making process.

About 28% of those familiar with the concept could not define it accurately – Figure 2. Among the most common mistakes, we mention the attribution of the

provision of ESs to human socio-economic systems or the consideration of ESs as actions of conservation and protection of nature.

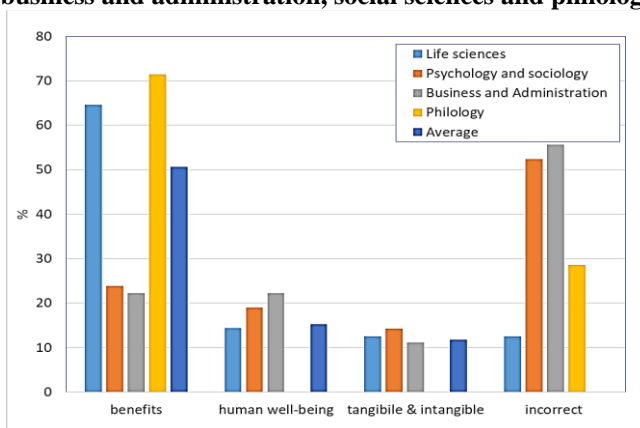
Figure 1. Percentage of students who declare they are familiar with the ESs concept



Source: Authors' own research.

To define the concept of ESs, students used phrases such as: "care and cleaning of the environment", "help regulate green spaces", "protect ecosystems", "benefits for natural or artificial ecosystems", "which refers to ecology", "representing human activities necessary for the maintenance of a clean environment", "all the components of nature and its components", "the place where different species live", "several elements correlated in nature", "the goods provided to the environment that helps to improve it with human help", "systems that bring us benefits", "services that take place within an ecosystem", "the benefits that human communities obtain from the ecosystems that exploit them" and even "services that keep track of green spaces and contribute to certain economic sectors, such as forestry, tourism and agriculture".

Figure 2. Students' knowledge of the ESs concept. Keywords of the concept of ESs mentioned by students with an academic background in life sciences, business and administration, social sciences and philology



Source: Authors' own research.

6. Conclusions

Urbanization creates a range of environmental, social, and economic challenges. Despite the small sample size, our research shows that students' knowledge of UES and their perception of the importance of UGI are related to their academic backgrounds. It demonstrates a need for a deeper understanding of environmental issues to increase the professional capacity of students and broaden their skills and competencies for the benefit of civic universities, students, and communities alike.

Although the desire to get involved in volunteer activities is encouraging, the different challenges students face and the need for enhanced knowledge require more innovation in academia. Informal training, service-learning activities in mixed groups with students from different faculties and fields of study, and engagement through the OpenLab initiative could be among the solutions universities can promote to give students opportunities to practically apply the theoretical knowledge and engage in problem-solving activities. Universities could better use information and communication technologies and develop interactive web interfaces to encourage open participation and barrier-free access to information. Thus, they open the opportunity for citizen science, which is undervalued in the region.

Acknowledgment

We thank Prof. Magdalena Iordache-Platis, Prof. Cristian Iojă, and Prof. Smaranda Witec for their support and involvement in organising the workshops. We also thank the Biology Students Association and the Sociology Students Association for disseminating the invitations. Our thanks also go to the University of Bucharest, which allowed the development of this project within the CIVIS OPENLABs Initiative.

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