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Mainstreaming Ecosystem Services and Biodiversity in Peri-Urban Forest Park Creation: Experience From Eastern Europe

Eliana Sevianu[1], Cristian Valeriu Maloş[1], Viorel Arghiuş[1], Nicoleta Brişan[1], Alexandru Sabin Bădărău[1], Marius Cătălin Moga[2], Liviu Muntean[1], Adrian Răulea[3] and Tibor Hartel[4]*

[1] Department of Environmental Science, Faculty of Environmental Science and Engineering, Babes-Bolyai University, Cluj-Napoca, Romania, [2] Atelier MASS, Cluj-Napoca, Romania, [3] Cluj Metropolitan Area Intercommunity Development Association, Cluj-Napoca, Romania, [4] Hungarian Department of Biology and Ecology, 3B Center, Babes-Bolyai University, Cluj-Napoca, Romania

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***Correspondence:**
Cristian Valeriu Maloş
cristian.malos@ubbcluj.ro

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The social role of peri-urban forests is diversifying, and this implies that peri-urban forests are redesigned to meet and shape social demands. A key challenge is the integration of the social demands for green spaces with the maintenance of key ecosystem structures and processes as well as the biodiversity of the green spaces. In this study, we report our experience and insights gathered through the implementation of a project targeting a peri-urban forest development near the city of Cluj-Napoca. One key particularity of the project was that it was designed by the city hall in cooperation with a major NGO, and the academic sector joined the project in its second stage, with the aim of mainstreaming ecosystem services and biodiversity within a well-established design concept. After comprehensively assessing the biodiversity and ecosystem services of the targeted forest, we found that the ecosystem supply was strongly related to the tree stand structure and the forestry management from the past decades. The public expressed concerns related to the parts of the established development design, which included built structures, artificial lights, toilets, and paved roads, perceiving that these actions will negatively influence the natural environment. We present the modifications undertaken in the project design after the public consultation and deliberation within the implementation team. An anonymous internal evaluation of the implementation team shows appreciation for the human and professional interactions and the resulting innovation and learning opportunities. To improve interdisciplinary collaborations, there is a need for a good institutional support and financial reward, transparency, and good communication within the team. At the end of the "Discussion" section, we present the insights gathered from this interdisciplinary experience in order to guide further similar projects in Central and Eastern Europe.

Keywords: urban ecosystem services, public participation, urban sustainability, Cluj-Napoca, transdisciplinary

INTRODUCTION

Over half of the world population and over 70% of population of Europe currently live in urban areas (Eurostat, 2018). Cities are becoming major nuclei for social and environmental sustainability because they are hubs for social interactions and innovation (John et al., 2015). The amount and the quality of urban green areas are strong determinants of the health and human quality of life, but the biodiversity underpinning the urban ecosystem stability is strongly affected by habitat loss, fragmentation, increased frequency of disturbance, import of new species, heat islands, altered atmospheric chemistry, pollution, and altered ambient conditions (Goddard et al., 2010). Therefore species, habitats, ecosystem structures, and functions which provide ecosystem services for the human society and also confer stability and high nature value to the ecosystems should be included in the landscape planning strategies (Ceauşu et al., 2021).

In the context of the development and expansion of the urban areas, the human pressure on the peri-urban ecosystems is expected to increase in the rapidly developing cities (Benedek, 2006; Bîrsănuc et al., 2019). Therefore, it is of utmost importance to develop operational strategies for integrating the ecosystem resilience and ecosystem services of the peri-urban green spaces with various human demands and to develop nature-friendly values and behaviors at the level of the society related to urban and peri-urban ecosystems (Gómez-Baggethun et al., 2013; McPhearson et al., 2015; Scott et al., 2018). Interdisciplinary and transdisciplinary approaches could be useful to develop sustainable peri-urban green space strategies because these approaches require the involvement of academic and non-academic stakeholders in order to identify the main sustainability issues as well as to address them (Maiello et al., 2011; Lang et al., 2012; Ahern, 2013). However, the implementation of such collaborative projects faces several challenges. On the one hand, differences in epistemology and paradigms on which formal institutions and different experts base their works and interpret key concepts (e.g., "ecosystem service," "sustainability") is a major challenge (Abson et al., 2014; Gómez-Baggethun and Martín-López, 2015; Kovács et al., 2015; Scott et al., 2018; Miller and Mössner, 2020). On the other hand the lack of the culture of cross-sectoral collaboration (Hossu et al., 2017) can further hamper the effectiveness of the interdisciplinary and transdisciplinary teams. Nevertheless, while the ecosystem service concept is well-established and matured in the academic literature, it is still largely missing from formal, institutionalized procedures, especially in Eastern Europe. Hence, a range of new concepts, which are established in the sustainability science literature, needs to be understood and accepted by local formal authorities and policymakers to be mainstreamed in the decision-making.

Reports on the challenges and opportunities for mainstreaming ecosystem services in decision-making through cross-sectoral collaborations for peri-urban ecosystems are scarce in the scholarly literature from Eastern Europe (e.g., Holzer et al., 2019). This part of Europe is important because institutions do not only lack the culture of collaboration (this being a general issue across Europe), but, often, they have conflicting views about what nature is and what is the relevance of nature for people (World Health Organization, 2017). This is often accentuated by the lack of the coordination in the urbanistic and infrastructural development, resulting in chaotic expansion of the built areas, often at the expense of high-nature-value green spaces (Niţă et al., 2018; Bîrsănuc et al., 2019). In this report, we present our collective experience gathered during a collaborative project (**Box 1**) implemented in the peri-urban area of Cluj-Napoca. The city is rapidly expanding due to socioeconomic development, and the expansion of the built areas often in the detriment of the green spaces was recently documented (Nagy et al., 2018; Bîrsănuc et al., 2019). One particular aspect of the project (**Box 1**), through which we developed the current report, was that the partner university was involved only in the second part of the project, when the key actions, as well as the forest design features, were already decided, and the ecosystem services and biodiversity needed to be mainstreamed while maintaining the broad identity of this design. From an academic perspective, this is an opportunity to experience the real-world institutional dynamics, shaping the condition of the urban green spaces, to explore the opportunities for mainstreaming key sustainability concepts in the ongoing projects as well as to learn about the challenges and opportunities emerging while doing this. Nevertheless, joining such projects probes the conceptual, methodological, and epistemological flexibility of the project implementation team and allows for improvements of the project outcomes even at later project stages. The objectives of the present report are the following: (i) to present the assessment of the ecosystem service supply and the social demand for the ecosystem services of a peri-urban forest (see below for definitions). These results were integrated into an operational strategy for the peri-urban forest development (a formal document owned by the city hall); (ii) to present the results of a public debate about the Town Hall's vision of the peri-urban forest and the ways integrating the public feedback into the final, implemented project; and (iii) to present our collective experience in the key challenges and opportunities for working in interdisciplinary team to advance peri-urban forest sustainability. We found this relevant from the perspective of further interdisciplinary and transdisciplinary project implementations, with respect to the management of interactions between the project members and the partners. Based on the insights gathered by our results, we propose four recommendations for sustainability initiatives, targeting the reconciliation of biodiversity, ecosystem services, and human needs in the peri-urban green spaces. These recommendations are partly rooted in the empirical results of the project and partly emerged from the collective experience with the project implementation.

MATERIALS AND METHODS

The Concept of Ecosystem Service

Ecosystem services are various types of benefits provided by ecosystems to people. Ecosystem services were included in various categories (provisioning, regulating, supporting, and

BOX 1 | The presentation of the project URBforDAN.
The project *Management and Utilization of Urban Forests as Natural Heritage in Danube Cities* (URBforDAN) was funded by the European Union within the Danube Transnational Program. The specific objective of the project was to foster sustainable use of natural and cultural heritage and resources of the urban forests. URBforDAN is being implemented in seven project partner cities: Ljubljana (SLO), Vienna (AT), Budapest (HUN), Zagreb (CRO), Cluj-Napoca (ROM), Belgrade (SRB), and Ivano-Frankivsk (UA). The project is implemented in Romania by the Cluj-Napoca City and the Cluj Metropolitan Area Intercommunity Development Association (IDA). Babes-Bolyai University joined the project in its second year of implementation. The project is intended to keep the current physiognomy of the urban forests (or even improve, when possible, its natural and cultural condition) while making sure that the forest areas become places for socialization, relaxation, recreation, and education. Also, a high-quality experience of natural heritage and green tourism for a diverse set of target groups has to be ensured. URBforDAN aims to improve cooperation between key actors to resolve conflicts and improve management of urban forests. At the same time, it aims to enrich "green tourism" in Danube Cities through new and improved services and products, accessible on over 700 h of urban and peri-urban forests. URBforDAN in Romania was implemented in a 40-h mixed deciduous forest (**Figure 1**) in the peri-urban area of Cluj-Napoca. The forest section is part of a larger forest, and it is situated on the border of a Natura 2000 site (being outside of the protected area). The project website is here: http://www.interreg-danube.eu/approved-projects/urbfordan.

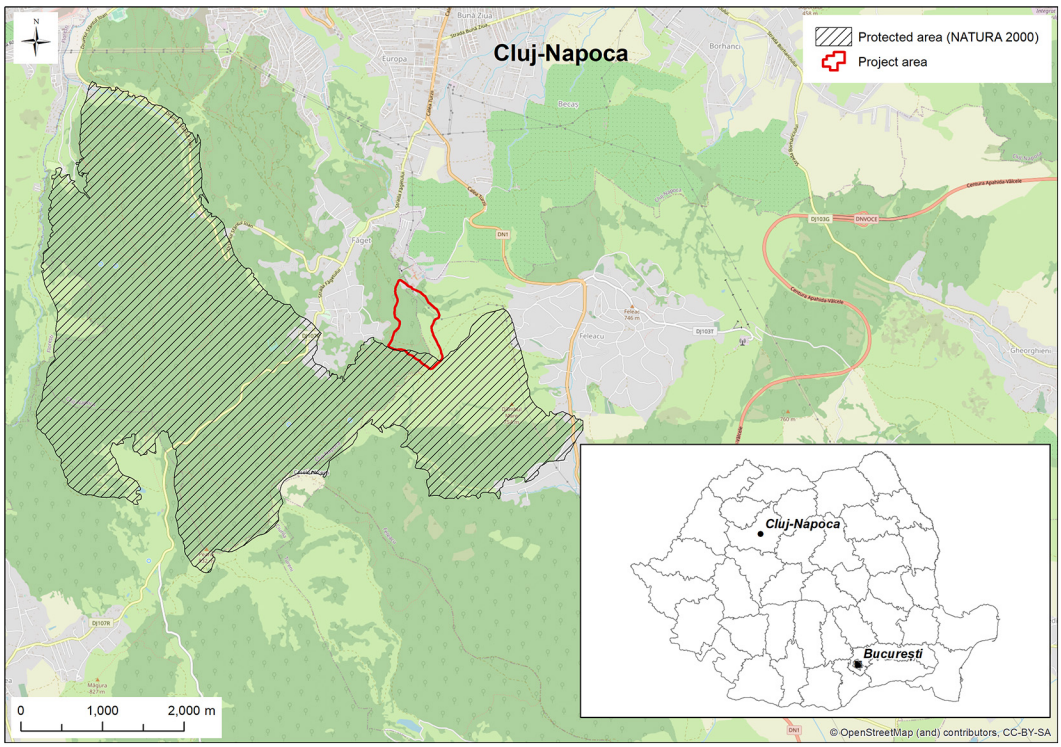

FIGURE 1 | The focal forest targeted by the project URBforDAN (outlined in red).

cultural) (Millennium Ecosystem Assessment, 2005). Sometimes, ecosystem services are conceptualized as being cocreated by human-related (e.g., social, technological) and natural capitals (Haines-Young and Potschin, 2012; Palomo et al., 2016; Schröter et al., 2017). We refer to ecosystem service supply as the capacity of the peri-urban ecosystem to provide a variety of ecosystem services, while the ecosystem service demand refers to the demand of the society for various goods and services (Baró et al., 2015). The ecosystem service mismatch refers to the situations when the ecosystem service demand and supply are not harmonized at the local level and manifesting either as unsatisfied demand or unsustainable uptake (Geijzendorffer et al., 2015; Wei et al., 2017). Ecosystem disservices are those contributions that represent potential threats or danger for people. In the present study, we ignored ecosystem disservices because these were unimportant in the past decade. Potential ecosystem disservices in the peri-urban forests in the study area are the adder (*Vipera berus*) and certain mushrooms; none of these are present in large density to become permanent threats.

Objective 1: Assessing the Ecosystem Supply and Social Demand for Ecosystem Services

We assessed the *ecosystem service supply* by considering different forms of ecosystem heterogeneity and ecosystem structures, whether biotic or abiotic (as suggested by Bennett et al., 2015, and see below), and by providing subjective ranks for these. We agreed upon the consideration of the following goods, benefits, and opportunities represented by the focal forest to the urban and peri-urban society and refer to these as "ecosystem services" in the following: (i) high-quality timber (hereafter timber), (ii) non-timber products (non-timber), (iii) biodiversity, (iv) soil

regeneration (soil), (v) recreation for people (recreation), (vi) learning about ecosystems and wild species (cognitive value), and (vii) scenic beauty. These ecosystem services are a combination between classically considered ecosystem services (e.g., timber and non-timber products, soil regeneration, recreation and scenic beauty (Millennium Ecosystem Assessment, 2005; The Economics of Ecosystems and Biodiversity, 2007; Orsi et al., 2020), and the recently proposed human-nature connection types (Ives et al., 2017). The ecosystem service supply was assessed on the following four forest vegetation structures existing in the studied forest, each assessed in the field. (i) Douglas Fir (*Pseudotsuga menziesii*) and *Larix decidua* plantation, planted ca. 40–60 years ago, both being introduced for economic purposes. This forest stand lacks horizontal structure, and due to the poor light and soil conditions, the underlying vegetation is not well developed. Ecosystem structures, such as the old and/or dying trees, are virtually non-existent, and the culturally modified trees (i.e., pollard, coppices) are absent in this forest stand; (ii) Tree stands consisting of Hornbeam (*Carpinus betulus*), Beech (*Fagus sylvatica*), and other trees scattered between them (most commonly Oak – *Quercus robur*; Maple – *Acer pseudoplatanus*) of roughly similar age (ca. 40–60 years) and without a pronounced horizontal stratification due to lack of substantial natural regeneration in the past decade. The light conditions are relatively better in this forest stand than in the Douglas fir plantation (See above.), and there may be elements of large old trees and culturally modified trees (beech and hornbeam coppice, especially along the dirt roads) within these forest stands. The leaf litter is overall well represented due to the low disturbances in the past decade; (iii) Forest parcels with well-pronounced horizontal stratification and diverse light conditions, where substantial natural regeneration of the trees also occurs. These forest parcels were reared in the past decade, but due to the lack of complete clearance of the trees, the natural regeneration created a heterogeneous forest environment. Hornbeam and beech coppices, as well as dead trees (fallen on the ground), are also present in this forest parcel. The richness of understory vegetation is overall high in these forest parcels; (iv) "Wild" areas with large old trees, dense-climbing shrubs (*Clematis* sp.), and dense and mature Common Ivy (*Hedera helix*) covering the large old trees, as well as dead wood (standing and fallen), and thick forest litter. This part also included areas, which are more difficult to access by people, a gully exposing geological formations (spherical concretions) due to the natural erosion and signs of natural disturbances (e.g., by wild boars). This section was left unmanaged for at least 50 years.

As an interdisciplinary team consisting of field biologists (botanists, zoologists), geologists, environmental scientists and ecosystem service researchers, we proposed ranks for ecosystem service supply (See below.) for each of the abovementioned four forest structures. The ranks were provided during deliberation exercises, each member knowing the forest well for many years and having multiple comprehensive surveys separately and collectively during the implementation of the project. The ranks provided to the assessed ecosystem services, ranged from 0 to 10, and these ranks reflected consensus and not averages. Sociocultural valuation approaches are commonly used in ecosystem service assessment (for both supply and demand) (e.g., Christie et al., 2012; Santos-Martín et al., 2017; García-Nieto et al., 2019). For some ecosystem services, such as carbon sequestration, water purification, soil erosion, extreme climatic event mitigation, and the air-quality improvement, we provided generally high ranks for every forest section as well as for the whole forest. In consequence, we decided to skip this information from results in order to avoid information overloading. We also made biodiversity assessments targeting the vascular plants, amphibian ponds, and the amphibians reproducing in them, reptiles, birds, and mammals, including bats. Furthermore, we inventoried the large old trees, including those that were culturally modified (i.e., coppices and pollards) and the geological structures that are visible and can potentially be relevant for people. We considered this biodiversity information in the deliberation exercises to establish the ecosystem service supply. Generally, more genuine structures, with high natural (e.g., places disturbed by wild boars, springs, and geological structures) and/or cultural (e.g., culturally modified trees) values, received higher marks in certain ecosystem service supply (especially to biodiversity, cognition, scenic beauty, and soil formation). We also included the existing network of human-made paths across the forest, as a sign of human presence and coverage (the forest is yearly visited by ca. 3,000 persons; see **Supplementary Annex 1**). In this respect, denser paths were considered as indicating more human activity (walking, jogging, and biking) based on the field evaluations. We acknowledge that the way we assessed ecosystem service supply is subjective, but such assessments based on expert judgment are common in ecosystem service assessment, given that the experts were well selected and embedded (i.e., they know well) the assessed system (Christie et al., 2012). We considered that such assessment of ecosystem service supply in relation to the mentioned forest ecosystem features was suited to the specific context of the project (i.e., the short time frame and the overall small size of the forest parcel, which makes a comprehensive survey and knowledge possible, and the lack of formal data on that forest parcel's ecosystem services supply) and yielded knowledge based on which actions could be planned and the middle and long impact of the interventions can be monitored.

The ecosystem service demand was assessed by a questionnaire survey implemented to 143 persons (the users of the targeted forest). The primary role of this questionnaire was not to serve scientific purposes (the project being not an academic project) but rather to help decision-makers and the project implementation team to understand the profile of the forest visitors. The questionnaire was developed by the main coordinator, the city of Ljubljana, and was implemented by every partner city, with local adaptations being allowed (**Box 1**) [see also Kičić et al. (2020) for the publication of these information and data]. The questionnaire survey was implemented in 2018–2019 (Kičić et al., 2020). The questionnaire assessed the main activities for which the visitors visit the forest. These activities were selected based on the knowledge of the local forest use culture and belonged to the following categories, namely *running*, *hiking*, *biking*, *spending time with family*, and *educational* activities, to learn and study nature. These activity categories were similar to those assessed in Zagreb by

Kičić et al. (2020). For each type of activity, the respondents were asked to mark the importance of that activity for them, with the following importance categories: *not important*, *low important*, *moderately important*, *highly important,* and *very highly important*. The questionnaire survey also included a section about the problems/challenges perceived for the forest as well as the suggested solutions for these (**Supplementary Annex 2**). We present the results only regarding the above activities and further information about the profile of those users, which provided a "very high" mark to a specific activity, which are presented in **Supplementary Annex 2**.

Objective 2: Assessing the Public Feedback for the Forest Design Proposal

We had an online public consultation on July 21, 2020, where the vision of the Town Hall of Cluj-Napoca was presented regarding the targeted forest, and its details are presented in **Table 1**. This development vision was inspired from the peri-urban forests around Stockholm (Sweden) and Berlin (Germany) where the forest experience and the recreative experiences of people are facilitated through a number and types of structural interventions (see **Table 1**) based on woody materials. Given the lockdown period and restrictions emerging from the coronavirus pandemic, the public consultation was popularized on the formal Facebook page of the Town Hall of Cluj-Napoca[1], being followed by over 20,000 persons as well as by a number of important NGO's (e.g., Cluj Metropolitan Area Intercommunity Development Association[2], followed by over 1,000 people). We carefully collected and analyzed every observation and comment coming from the public consultation (either expressed verbally or written down *via* Zoom discussions and chat) as well as every Facebook comment. Facebook comments received within 3 days from the event posts and presentation were analyzed (a subjectively taken time period). These observations were transcribed and/or copied, and then were grouped in different categories based on the attitudes and viewpoints they expressed. We were aware that the methodology we used to assess public feedback was unconventional, but it was the only way through which we could consider public feedback. Every comment was considered by the project implementation team and was integrated into the final implementation project (the implementation of the project is ongoing in the target forest while we write this work), together with the ecosystem service and biodiversity assessment results.

[1]https://www.facebook.com/PrimariaClujNapocaRomania

[2]https://www.facebook.com/ClujMetro

Objective 3: The Challenges and Opportunities of Interdisciplinary Projects as Experienced by the Project Participants

As this type of project was new to most of the team and partner members, we developed an online platform to assess the experience of the project members directly involved in the activities related to the Objectives 1 and 2. The project members, which also included the coauthors of this work, were asked to respond to the following questions: (i) Enumerate the positive experiences as well as the challenges related to the collaboration with colleagues from the same institution; (ii) enumerate the positive experiences as well as the challenges related to the collaboration with the administrative structures from the same institution; (iii) enumerate the positive experiences as well as the challenges related to the collaboration with the partner institutions; and (iv) what solutions do you suggest for

TABLE 1 | The items proposed in two peri-urban park developments and how these changed after the public consultations.

Intervention types	Initial proposal	Public perception through consultation	After public consultation	Final decision and implementation
Wooden benches	37	Mixed	Kept	37
Wooden tables	3	Mixed	Kept	3
Signs for marking different trails and activities – a short version	28	Positive	Kept	28
Signs for marking different trails and activities – a long version	26	Mixed	Kept	26
Templates for marcation of less used side trails for hiking/cycling/horseback riding	7	Mixed	Kept	7
Entrance point information tables	9	Mixed	Reconsidered	6
UPF information and natural heritage interpretation totems	28	Positive	Reconsidered	50
Wooden structures (e.g., educational, geologic, sport)	6	Mixed	Reconsidered	5
Auxiliary functions (toilets)	3	Mixed	Reconsidered	2
Wooden paths	9	Mixed	Reconsidered	3
Light system	1	Negative	Removed	0
Insect hotel	0	Positive	Newly added	40
Amphibians	0	Positive	Newly added	3
Bats	0	Positive	Newly added	7
Birds/Dormice	0	Positive	Newly added	40

improving the collaboration within such inter disciplinary and transdisciplinary projects?

Analysis

Ecosystem service supply was visualized with circumplex (polar bar) charts in R (with the packages *ggplot2* and *dplyr*). These charts are similar to the flower diagrams, where each "petal" of the flower reflects an ecosystem service, and the relative size of the petal represents the ecosystem service capacity of the forest considered. The size of the petals was determined by the marks provided by the expert evaluators and represented a consensus number (from 0 to 10; see above). We created one chart for each of the four forest vegetation structures. The results of the questionnaire were visualized through grouped (stacked) bar plots, where each activity and its level of importance were shown. The textual information was analyzed qualitatively, and the results were presented in the form of a succinct narrative, which encapsulated the key realities and shared agreement of each respondent.

RESULTS

Ecosystem Service Assessment for the Peri-Urban Forest

We found differences in the estimated ecosystem service supplies within the four forest structures. In the *Douglas fir* monoculture, the supply was high for timber, but, according to our estimations, the other services were relatively weak (**Figure 2**). On the contrary, the *Beech and Hornbeam* (with a relatively homogenous tree age stand) and the *Hornbeam and Beech* (with natural regeneration) had more balanced and relatively high potential to supply various ecosystem services, except the timber value, which was lower for both types relatively to the *Douglas fir plantation* (**Figure 2**). The *Unmanaged* (wild) forest section had relatively low potential to supply timber and non-timber products, while the other ecosystem service supplies were high (recreation) or maximum (the other types) (**Figure 2**).

The demand for ecosystem services was high for recreation types of activities such as running, biking, hiking, and spending time with family (**Figure 2**). The forest was used to a lesser extent for educational types of activities, although the "supply" with wild and naturally valuable forest components is high (**Figure 2**). Challenges and problems, which were perceived by most of the persons, were illegal and excessive logging, loud music, garbage, off-road activities (cars and motorbikes), and grills (and the associated fire and smoke) (**Supplementary Annex 2**). The suggested solutions included biodiversity assessment and conservation measures, hiking and biking trail improvement to guide the visitors, more intensive field trips by the local schools and pupils, and picnic areas, as well as the creation of an adventure park (see **Supplementary Annex 2** for other suggestions for the main visitor's profiles).

Considering Public Feedback

Table 1 presents the intervention types proposed within this initial proposal. These initial interventions were decided also according to the results of the questionnaire survey (see below and **Supplementary Annex 2**). Fifty-four responses were received; out of which, six were directly asked during the online

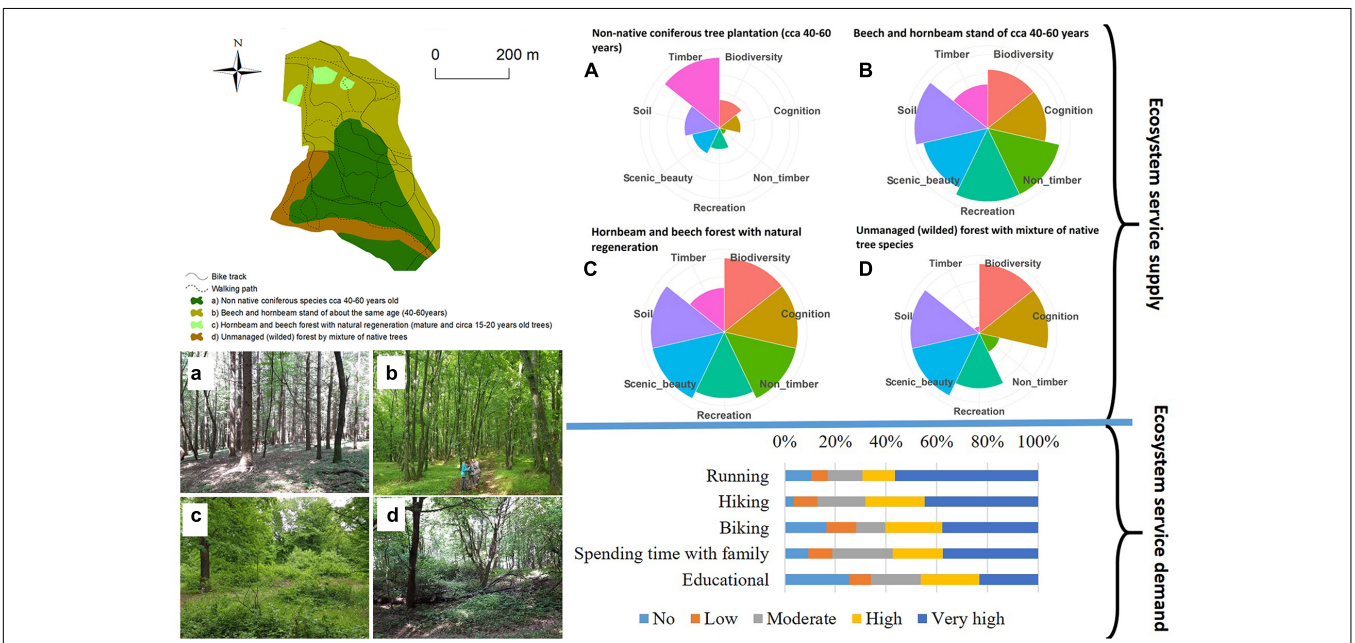

FIGURE 2 | Ecosystem service supply and demand for the focal peri-urban forest area. **Up left:** a map of the four different forest vegetation structures. **Down left:** representative pictures, showing the physiognomy of the four different forest vegetation structures (coniferous tree plantation, beech and hornbeam stand, beech and hornbeam with natural regeneration, and unmanaged forests). **Right:** ecosystem service supply and demand for the four types of the forest areas.

consultation, and 45 were written as Facebook comments (nine responses were irrelevant, because they contained one to two words). Feedback for the initial development proposal (**Table 1**) was included in the following three categories: "positive without critics" ($n = 8$), "positive with critics" ($n = 6$), and clearly negative ($n = 31$). The positive feedback highlighted the need for such parks in the peri-urban forests of Cluj-Napoca; a number of feedback also highlighted that this is a common practice in the economically developed western countries as well. Some critics highlighted skepticism toward the environmental decisions of the city governance. Other critics expressed concerns about the threats represented by human interventions to the integrity of the natural environment within the targeted forest. These critics highlighted the placement and the amount of constructions, artificial lights, and paving of certain road sections and the unnecessary increase of the human presence and associated behaviors, with negative impact on the environment.

Because of the feedback, the implementation team proposed changes in the infrastructure, where certain features (e.g., artificial lights, paved roads) were removed, while new elements (e.g., insect hotels, artificial nests for birds) were included. These are presented in **Table 1** (see the column "Final decision and implementation"). The final proposal consisted of built wooden structures, aiming to facilitate nature experience and the formation of diverse human-nature connections, learning about biodiversity elements and ethical behavior in the forest (i.e., regarding noise, garbage, and attitude toward wildlife), as well as biodiversity conservation through creation of habitat substitutes (**Table 1**). Part of these actions was also consistent with the suggested solutions, which emerged from the questionnaire surveys (see **Supplementary Annex 2**).

Challenges and Opportunities for the Interdisciplinary Project as Perceived by the Project Team Members

Overall, eight project members, belonging to each partner (the architects, the town hall, the university) responded to the questions about the experience with the project implementation. Regarding the *collaboration between the colleagues from the same institution,* there were eight responses. The participants highlighted the positive responses: the trust between the colleagues, the experience of the colleagues with the various topics covered by the project, the diversity of the knowledge and epistemology, the fair attitude of some colleagues, the creativity, and the dedication. The challenges highlighted by the participants included the difficulties in integrating the project activities into the institutional obligations, some inconsistencies regarding the responsibilities, a high workload due to other projects, the time schedule of meetings was difficult to integrate into the existing activities, and communication between some project members. The solutions proposed to improve collaboration were the increase of institutional support for interdisciplinary and transdisciplinary research, better financial motivation, the reduction of bureaucracy, better communication between the colleagues and better awareness and establishment of the responsibilities of each member. *Regarding the institutional support for interdisciplinary projects*, five out of eight people did not provide any response. The positives were the professionalism of the administration, the quick signatures of formal papers, and the openness for help regarding the logistic and administrative aspects. The challenges were reported only by one person and were related to the high load of paperwork, the delays in payments, and the high number of the administrative persons. The solutions for the administrative aspects were the reduction of the time needed for the signature of the contracts and the other administrative aspects, as well as a more pleasant communication. Regarding the *collaboration with other institutions within this project*, the positives were the openness to collaboration between the different institution members (the university, the town hall of Cluj-Napoca municipality, as well as NGO's), the determination to deliver high-quality results, creativity, and the complementary character of expertise and support (eight responses). Perceived challenges were the lack of orchestration (i.e., the sometimes-chaotic character of inter-institutional dynamics), difficulties in understanding the ways how partners conceptualize the project, its key concepts (i.e., sustainability) and outcomes, the lack of dedication from the partners, the lack of full transparency around some project aspects (eight responses). The solutions proposed to improve the collaboration between institutions were the following: more communication between the partner institutions through the key representatives, more common experiences, establishing clear responsibilities and deadlines, clear definition of key concepts, and a full understanding of the project vision by each partner right at the beginning of the project (eight responses).

DISCUSSION

The peri-urban forests are expected to play an increased and diversified social role with the amplification of the lockdown periods associated with the pandemic (Pamukcu-Albers et al., 2021). The major challenge in this respect is to recognize ecosystem structures and processes, as well as natural habitats and native biodiversity, into the governance strategies of peri-urban green spaces while allowing a diversified social experience in these areas. We will frame the discussions in a way that encapsulates insights emerging from the collective experience with the implementation of this project, with the hope to assist better implementation of similar projects elsewhere and in the future.

Ecosystem Service Assessment in Peri-Urban Forests

We showed that the ecosystem service supply of the studied peri-urban forest related to the tree stand structure can be quantified through field surveys. While the supply of ecosystem services was high for biodiversity, learning (cognition), scenic beauty, recreation, and soil formation for the tree stands with the native trees were very low for the non-native coniferous plantation. The ecosystem service mismatches caused by low demand for learning about nature and forest biodiversity as well as about the role of forests in soil formation in the focal forest can be explained by a combination of cultural and availability

aspects. The culture of learning about biodiversity and ecosystem processes has only recently formed in Cluj-Napoca, mainly due to the emerging NGO and other initiatives. For example, NGO's like the Romanian Ornithological Society, the Ecouri Verzi, and Somes Delivery regularly organize field trips and activities, targeting the urban and peri-urban green spaces of Cluj-Napoca, where learning about the natural environment is in focus (the co-authors of this paper present in these activities). On the other hand, the focal forest is distant relative to other peri-urban forests, and this may represent accessibility barriers for certain cultural ecosystem services (Ala-Hulkko et al., 2016). Further research should identify the supply and demand for different cultural ecosystem service types at the level of Cluj-Napoca and the accessibility of the peri-urban ecosystems to satisfy these demands (*sensu* Baró et al., 2016). In the approach, we use the ecosystem service concept as a complementary tool for the biodiversity assessments and not as a means to replace these. For example, the protected Yellow-Bellied Toad (*Bombina variegata*) sometimes avoids "wild" areas because these are dark (lack of light), and there are no suitable ponds for them (Hartel et al., 2007), and it can be often found along ponds formed after heavy machinery (such as forest exploitation) (Hartel et al., 2014). Therefore, a careful weight is needed in the development of management plans for the peri-urban forests, where the biodiversity and ecosystem service provision are valued and managed and the key role of certain interventions for sustaining biodiversity is recognized (Ramel et al., 2020).

Public Feedback for the Peri-Urban Forest Design

By analyzing the feedback for the forest design proposal for the focal forest, the dominant attitude was a "green" (or "ecological") attitude: people showed their concerns about the natural integrity of the focal forest, which is vulnerable to excessive amounts of infrastructure and people. This attitude may have its roots in the culture of activism (see Botcheva, 1996; Soare and Tufiş, 2020) or, possibly, in the mistrust in the environmentally relevant decisions. Indeed, the green spaces within and outside the city of Cluj-Napoca went through sharp deterioration and shrinkage in the past decade, and the expansion of the city in the peri-urban areas (Bîrsănuc et al., 2019) negatively affected even the formally protected Natura 2000 sites (several reports of the local experts).

The public feedback expressing concerns about whether the environmental impact of the proposed development project is legitimate and also in line with the general policy of participatory governance encouraged by the city of Cluj-Napoca; however, we also call for a better understanding of the contextual aspects (social, environmental, and ecological) related to the focal forest, its naturalness and vulnerability, as well as some emergencies appearing at the level of the urban population, especially in the context of the potentially amplifying pandemics and the associated lockdowns. We will enumerate these based on our collective experience with the focal forest and, in general, the peri-urban green spaces. First, the focal forest is situated outside the Natura 2000 area, and it is a commodity production forest with nearly half of its area consisting of coniferous (non-native) plantation (see **Supplementary Annex 1**). This forest stand has the lowest levels of supply for all types of ecosystem services measured, and its level of naturalness (*sensu* Machado, 2004; Ferrari et al., 2008) is low. The focal forest was taken out formally from timber production in order to be transformed into a park where the vision is to integrate ecosystem services, nature conservation, and societal goals. Second, the focal forest is already visited by urban people (ca. 3,000 per year; see **Supplementary Annex 1**), with a dense dirt-road network made partly by the visitors. Sadly, despite some waste-cleaning activities implemented on a volunteer basis, garbage is constantly accumulating in the focal forest, even in habitats for endangered and protected species such as the yellow-bellied toad. This situation calls for a more careful institutional embracement of the focal forest, since an increased number of people, without a proper behavior and the culture of enjoying the benefits of the forest, visiting the forest will lead to the sharp deterioration of the forest. The project implementation team embraced this issue by increasing the amounts of information for the public on various information panels about the forest as an ecosystem, key species and habitat, as well as human behavior related to these. Third, the 3 months of the lockdown period shown during the coronavirus outbreak showed that the human demand for the peri-urban nature can explosively increase. Potential intensification of the lockdown period, in combination with the large urban and peri-urban population of Cluj-Napoca (**Supplementary Annex 1**), the scarcity of available genuine green spaces due to chaotic urban expansion (Bîrsănuc et al., 2019), and an improper culture of using the forests (see above) will imply even more intense and destructive human activity in the peri-urban green spaces.

Because of the public feedback, the project implementation team considered that changes are necessary in the development plan. By reducing the urban elements in the forest and increasing the structures built for biodiversity, the overall vision for transforming the focal forest in an arena of learning about biodiversity, the need for its conservation, and experiencing nature will be better achieved. There is an urgent need to develop a coherent, assumed, and ready-to-be-developed social–ecological strategy for the conciliation of the biodiversity conservation and broader societal demands for nature in the peri-urban green spaces of Cluj-Napoca and other major cities. We propose that, within such a strategy, the areas with high naturalness (i.e., low proportion or absence of exotic species, high number of natural ecosystem structures and processes, high number of protected species and their habitats, natural physiognomies) should be identified and managed with reduced human interventions (with very low levels of built structures, where the cognitive, emotional, philosophical, and relational values related to nature are promoted) and for biodiversity. The society will benefit after such areas through a broad range of ecosystem services and human nature connections, which should be explicitly recognized and promoted. We believe that the forest areas with the dominating species of exotic tree plantations can be managed in a similar manner as the forest presented in this paper; however, balancing societal and conservation needs should be done at each newly targeted site, and ecological restoration should be considered whenever it is feasible.

The Challenges Working in the Interdisciplinary Project

Bettencourt and West (2010) point that "the many problems associated with urban growth and urban sustainability, however, are typically treated as independent issues. This frequently results in ineffective policy and often leads to unfortunate and often disastrous unintended consequences," highlighting the need for integrating different forms of knowledge and expertise within interdisciplinary and transdisciplinary frameworks in order to generate innovative and actionable knowledge for urban green space sustainability. Newig (2007) highlighted that the effectiveness of the heterogeneous groups can be improved by open communication, transparency, fairness, clear establishment and acceptance of the rules, impartiality of mediation, and openness to considering different opinions, knowledge, and emerging consensus (see also McGregor, 2017; Kenter et al., 2019). The feedback on the experiences with the project URBforDAN largely covered the above-enumerated conditions, and this calls again for the consideration of institutional support for transdisciplinary research teams. Landscape architects need to work closely with ecologists, environmental scientists, and social scientists in order to develop socially and ecologically resilient peri-urban green spaces, and this collaboration needs to start even from the conceptualization of these strategies. Watkins et al. (2018) present a community of practice approach for urban forest management, where different stakeholders (i.e., forest users) and the representatives of formal institutions interact to advance sustainable management of forests.

CONCLUSION AND RECOMMENDATIONS

In this case study, we present the challenges and opportunities related to the development and implementation of a peri-urban forest management plan. While being local in character, our case study reveals social–ecological system features which may be common to other peri-urban forests from Romania and Eastern Europe. Based on the results, as well as our collective experience, we make the following recommendations for the initiatives, targeting the reconciliation of biodiversity, ecosystem services, and human needs in the peri-urban green spaces.

1. *In situ evaluation of ecosystem services by also considering non-monetary methods* (such as those based on deliberative exercises by the experts, as used in this study). In this study, we showed that a group of interdisciplinary team with good knowledge about the woodland environment can evaluate ecosystem service supply and demand based on commonly agreed ecosystem features. The positive aspect of such evaluation is that it works relatively fast, it can be used in emergency situations when no formal data are available, and it allows to distinguish between vegetation structures and other natural and cultural features. This approach can be extended for the whole peri-urban green spaces and state-of-the-art techniques (e.g., drone monitoring, GIS modeling) can be used to assess and analyze the spatial scale of ecosystem service bundles and their relationship with biodiversity in the peri-urban areas. In order to be successful, flexibility is needed in determining the spatial position of each built structure and intervention in the targeted ecosystem as well as in the number of structures based on the ecosystem service and biodiversity assessment results. In this project, this was only partly possible, since the academic sector was only involved in the second stage of the project.

2. *Develop a socially and ecologically sustainable culture of forest use.* The increasing social demand for using forest and natural green spaces around the cities associated with cultures and behaviors, which are unsustainable ecologically and socially (noise, garbage) will probably amplify the deterioration of the natural values of these green spaces and will alienate people from these areas. There is an urgent need to assist the visitors with proper information and, naturally, also, acceptable logistics in order to raise awareness of the values and fragility of the natural areas and to foster the development of nature-friendly culture. This will likely be beneficial for the urban society as well, especially in the context of amplifying lockdowns and climate variations (heat waves).

3. *Institutional support for transdisciplinary teams*. In several cities and towns where academic institutions are present, transdisciplinary teams can be developed. There are multiple benefits of such teams, including their role knowledge and innovation hubs, which can represent a needed complementation for the existing formal institutions. Such teams can act also as communities of practices and can be involved in the social-environmental monitoring of the peri-urban green spaces and in the periodical adaptation of the management strategy according to the new challenges and opportunities. The establishment and the effectiveness of such teams, however, require ambitious reconsideration of the ways how institutions (academic and non-academic) and, within these, different institutional units (e.g., faculties within the universities) work and collaborate and the ways the transdisciplinary academics are motivated (Hartel et al., 2019).

4. *The need for transparency regarding the intentions of the main stakeholders* (city governance, owners, academic and non-academic representatives) related to the targeted peri-urban green spaces. Often, these intentions will drive the long-term condition of the peri-urban forests, and without knowing and discussing them right at the beginning of the project, the future of the targeted green spaces will remain uncertain, despite the good implementation of a given project at a given time.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

ES: conception and design, acquisition of data, data interpretation, and writing the manuscript. CM: conception

and design, acquisition of data, spatial analysis, and data interpretation. VA, AB, LM, and NB: acquisition of data. MM: architectural concept. TH: conception and design, acquisition of data, development of theory, and writing the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2021.618217/full#supplementary-material

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