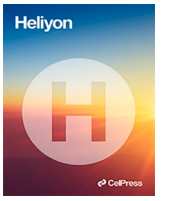
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Research article



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

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ABSTRACT

Assessing preferences of recreational activities related to cultural ecosystem services (CES) in urban areas is essential for decision-making and urban green space (UGS) management. This work aims to assess the preferences and factors (based on socio-demographic and motivation variables) influencing CES-related activities in Vilnius, Lithuania, to provide scientific knowledge to support more efficient UGS design and management. Participatory mapping was reported as relevant for urban park planning and decision-making and was applied to identify spatially explicit CES. We assessed the perceived relevance of five CES-related activities groups (*Social activities*, *Inspirational activities*, *Cultural activities*, *Spiritual activities*, and *Physical activities*) via participatory mapping through an online survey (n = 1.114). The users selected one preferred geographic location for each CES-related activities group and attributed relevance (using a 5-point Likert scale) for a set of motivation items. The results showed that *Physical* and *Social activities* were the respondents' most important CES-related activity groups, while *Spiritual activities* were the less popular. Factor Analysis showed that the respondent's recreation experience preferences, or motivations, were the most relevant variables influencing all the groups except for the *Social activities* group. Regarding *Cultural activities*, preferences for *understanding things & learn about history* were the most relevant variables. For *Inspirational activities*, the variables *developing knowledge & to learn* were the most important. *Enjoying nature's quietness & frequency* was the most relevant for *Physical activities*. Regarding *Spiritual activities*, the most important variables were related to the *development of spiritual activities* and the *reflection on personal religious values*. Finally, *socio-demographic variables* mainly influenced social activities, namely *education level*, *gender* and *age group*. The spatial distribution was different between activity groups. *Inspirational activities* showed the highest dispersion, and *Spiritual activities* the highest concentration. The results of this work are relevant to municipal managers, as they allow for a better understanding of users' interactions with the territory, its multifunctionality, and potential areas of conflict between conservation and recreation.

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1. Introduction

Cultural Ecosystem Services (CES) are one component of ecosystem services (ES) [1]. ES are considered natural benefits to humans [2]. CES are defined in the Millennium Ecosystem Assessment as the "*non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences*" [2]. CES consider the characteristics of ecosystems that contribute to people's physical and mental wellbeing that derive from contact with nature [1,3–5]. They are directly experienced and subconsciously appreciated by people. This differentiates CES from regulating and provisioning ES [6,7]. CES are the most demanded ES by urban residents [8]. Their value is especially relevant in larger urban areas, where urban green spaces (UGS), e.g., parks, gardens, urban forests, agricultural plots, or cemeteries, are scarcer [9] and are the only places available for urban dwellers to interact with nature [10]. According to Bolund and Hunhammar [11] urban ecosystems are "*all natural green and blue areas in the city, including in this definition street trees and ponds. (…) Street trees are stand-alone trees, often surrounded by paved ground. Lawns/parks are managed green areas with a mixture of grass, larger trees, and other plants. Areas such as playgrounds and golf courses are also included in this group*". Urban ecosystems are composed of the urban areas and the areas that surround them. "*They are very peculiar ecosystem types: they are almost completely artificial but they include, in different proportions, all other ecosystem types (forests, lakes and rivers and agricultural areas can all be part of urban fringe) and they are strongly influenced by human activities*".[1]

However, their role and existence are threatened by the current urban growth and densification [12]. This brings new challenges to population wellbeing in cities. CES are key to wellbeing, and there is a need to quantify the CES supplied by UGS [13,14]. Some authors defend the inclusion of ES in land-use planning and policy-making agendas [15]. Nevertheless, CES still need to be better quantified and included in decision-making [16–18].

Although scientists and decision-makers recognize CES as a key societal element, they have yet to be better studied [18,19]. Their intangibility makes them difficult to study and assess their value [19–21]. Kosanic and Petzold [19] and Milcu et al. [21] showed that the world coverage for CES studies still needs to be improved, especially at the urban level. Milcu et al. [21] found that only 3 out of 106 CES works were focused on the urban context, namely in Birchwood, Harrington, UK [22], in Buffalo city municipality, South Africa [23], and in Lugano, Lucern, and Zurich, in Switzerland [24]. The revision conducted by Kosanic and Petzold [19] focused on the link between CES and wellbeing and found few articles focused on urban areas (e.g., Helsingborg, Hassleholm, and Staffanstorp, in Sweden [25], Phoenix in Arizona, USA [26], or the towns of Kamiichi, Yoshino, Akiota, and the city of Oita, in Japan [27]). O'Brien et al. [28] assessed European studies on CES in urban and peri-urban green infrastructure. In total, they found 56 studies from southern Europe (FIRO Macedonia, Portugal, Serbia, Spain), western Europe (Austria, Belgium, Germany, Netherlands, Switzerland), and northern Europe (Denmark, Finland, Sweden, United Kingdom). None of them was focused on urban CES in the Baltic states. To our knowledge, only two recent studies focused on CES in Vilnius. One focused on mapping [29], and the other on a single park in the city [30]. Therefore, more studies are needed in this part of the globe focused on urban CES. This is especially relevant in the generalized context of the growth of the world's urban population [12]. To make these studies more accurate, it is critical to understand the factors influencing urban dwellers to use CES [31].

Participatory mapping methods, also known as public participation GIS (PPGIS), are participatory methods that engage people in generating spatially explicit information for various urban, regional, and environmental applications [32–34]. PPGIS surveys are adaptable to various social survey contexts [32]. The participants identify spatial locations on a physical or digital map using various tools, e.g., stickers, markers, or digital annotations. Subsequently, they respond to a survey [31]. These methods have been widely used to assess CES since the 1990s [32,34,35].

The aim of this work is thus to assess, through participatory mapping, the preferences and factors influencing CES use in an urban context in Vilnius, Lithuania. For this study, we consider a set of five groups of CES-related activities (*Cultural activities*, *Inspirational activities, Physical activities*, *Social activities*, and *Spiritual activities*) associated with different CES subgroups, similar to Cao et al. [36]. Regarding the factors affecting CES use, we consider different socio-demographic variables and a set of motivation items derived from the Recreational Experience Preference scale developed by Driver [37]. The specific objectives include the assessment of (1) main socio-demographic variables linked to preferences on CES-related activities groups; (2) preferred CES-related activities groups; (3) factors influencing preferences for the different CES-related activities groups (assessment of associations between socio-demographic variables and user motivations); and (4) elements (e.g., land use, landscape elements, and spatial distribution of cultural, recreational, and spiritual equipment) affecting the spatial distribution of preferred locations for the different CES-related activities groups.

2. Materials and methods

2.1. Study area

Vilnius is the capital of Lithuania (Fig. 1) and the second-biggest city in the Baltic states. It is located in the northeast part of Europe. It has a continental climate (Köppen-Geiger: Dfb) characterized by a cold climate, without a dry season, and with a warm summer [38]. Vilnius has a population of 588,412 inhabitants [39] and a population density of 1337 inhabit./km.[2] The city has one of the largest surviving old towns in Northern Europe, with a medieval layout and a mixture of Gothic, Renaissance, Baroque, and Classical architecture, and it has been classified as a world heritage site by UNESCO since 1994.[2] According to the Husqvarna Urban Green Space

[1] https://biodiversity.europa.eu/europes-biodiversity/ecosystems/urban-ecosystems.
[2] https://whc.unesco.org/en/list/541/.

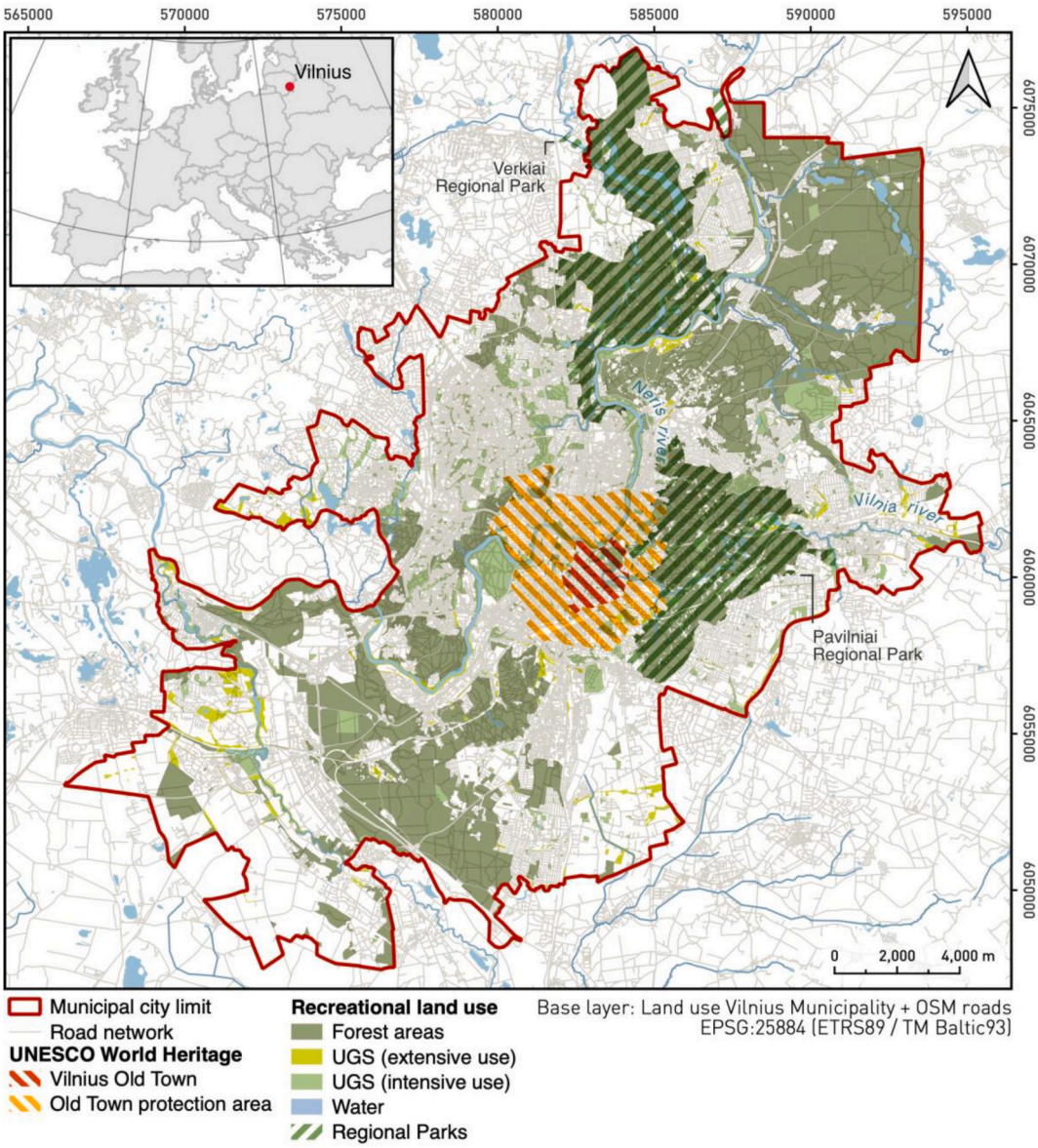


Fig. 1. Vilnius city with recreational land use areas and areas with protection status (UNESCO World Heritage and Regional Parks).

Index (HUGSI)[3] Vilnius is one of the greenest European capitals. The city has many recreational UGS. In its Master plan, Recreational UGS cover an area of 73.52 km^2 (18.4% of the municipality), representing 124.95 m^2 per capita.

2.2. Data collection

A PPGIS online survey was developed using the ESRI Survey 123 platform for ArcGIS [40]. Here, we assessed the perceived relevance of specific preferences for a recreation experience [37] associated with five CES-related activities groups. The survey was conducted between January and May 2021. It was composed of three main sections (Table S1 in supplementary material). The first explained the survey's background, research team, and aim. In the questionnaire introduction section, we specifically mentioned for the users to identify ecosystem services supplied by nature in Vilnius. The second section included five maps for the identification of respondents' preferred locations for the five CES-related activities groups: *Cultural activities*, *Inspirational activities, Physical activities*, *Social activities*, and *Spiritual activities*. The users were asked to zoom in to their preferred locations on each map and tag a point

[3] https://hugsi.green.

Table 1
–CES-relates activities groups, CES association, and types of recreation experience preferences by the group.

Activity group	CES association	CICES v5.1 code*	type of recreation experience preferences
Social activities	Associated to CES which promote social interactions, e.g., doing picnics, seating in a bench with friends, walking with other senior users.	3.1.1.2	To be with friends To be with family To meet new people
Inspirational activities	Associated to CES which promote knowledge, and inspiration, e.g., scientific, educational, aesthetic appreciation.	3.1.2.1 3.1.2.4	To develop knowledge To learn about things To enjoy uniqueness of the place
Cultural activities	Associated to CES which promote or provide cultural benefits for the users, e.g., educational, cultural, heritage.	3.1.2.2 3.1.2.3 3.2.1.3	To learn history and traditions To understand things To attend cultural events
Spiritual activities	Associated to CES which promote spiritual experiences associated to nature, e.g., symbolic, sacred or religious.	3.2.1.1 3.2.1.2	To meditate To develop spiritual activities To reflect on personal religious values
Physical activities	Associated to CES which promote recreational, both passive and active interactions with nature, e.g., walking, cycling, sailing.	3.1.1.1	To be close to nature To be where is quiet and in peace To relax

* CICES v5.1 class codes. Some classes can be linked to more than one activity group, class code corresponds to dominant group.

associated with each activity. Subsequently, they were asked to rank each activity using a 5-point Likert scale (1 – very unimportant to 5 – very important). For each type of activity, the user was further asked for the importance of three different items regarding recreation experience preferences (based on Driver [37]) (see Table 1), also using a Likert scale approach. The visit frequency was also collected. In the third section, socio-demographic information was collected, including gender, age group, level of education, average distance the users are willing to travel to engage in recreational activities, and participation in environmental activities (volunteering for NGO activities). The survey was directed exclusively at Vilnius inhabitants. 1576 responses were collected, from which 1114 were considered valid (Answered to all the questions). The collected data represents the Vilnius population at a 95% confidence level, with a 3.05% confidence interval. The list of fields collected is included in the supplementary material (Table S1).

2.3. Statistical and spatial analysis

For statistical analysis, we considered five control variables (*Cultural activities*, *Inspirational activities, Physical activities*, *Social activities*, and *Spiritual activities*), and a set of 4 groups of independent variables; (i) Socio-demographic group – *gender*, *age group*, *education level*, *transportation preference*, (ii) geographic group – *distance willing to travel* to perform activities in nature, (iii) Motivation variables per CES-related activities group – sub-group *Social activities - to be with friends*, *to be with family*, *to meet new people*; sub-group *Inspirational activities – to develop knowledge*, *to learn about things*, *to enjoy the uniqueness of the place*; sub-group *Cultural activities – to learn history and traditions*, *to understand things*, *to attend cultural events*; sub-group *Spiritual activities - to meditate*, *to develop spiritual activities*, *to reflect on personal religious values*; sub-group *Physical activities – to be close to nature*, *to be where is quiet and in peace*, *to relax*; variable common to all sub-groups – *frequency of activities*); (iv) Environmental awareness group – *frequency of engagement in environmental activities*. To identify relevant socio-demographic variables (Objective 1), a Kruskal-Wallis test was applied to identify significant differences in independent variables. If significant differences ($p < 0.05$) were found, a Tukey HSD posthoc test was applied. Descriptive statistics were also used to assess preferred CES-related activities groups (Objective 2). Based on the correlation matrix, an exploratory factor analysis (FA) was carried out to investigate the relationship between variables and find potential factors influencing variables' relations (Objective 3). Before proceeding with the FA, Bartlett's test for sphericity was run to assess the variance between the groups to verify if the correlation between variables exists, in which case the FA can occur. A Varimax rotation was applied for the FA. Horn's parallel analysis calculated the number of factors per park [41]. Loadings $\geq +0.4$ and ≤ -0.4 were retained as explicative of each factor. The analyses were carried out in RStudio software (macOS version March 1, 1093), using the following libraries: for Horn's parallel analysis – Nortest [42]; for Tukey's test – DescTools [43]; for compact letter attribution for pairwise comparisons – Rcompanion [44]; for Bartlett's test for sphericity – Psych [45]; for Kruskal-Wallis test and Factor analysis – R internal Stats library; for plot preparation – Ggplot2 [46] and Ggpubr [47]. The spatial analysis was conducted to assess the city's distribution of all registered activities (Objective 4). The analysis included the spatial distribution and concentration analysis (Grid Map option in the Visualist plugin for QGIS; [48]). Standard Deviation (SD) ellipses (CrimeStat method, 500 m radius; [49]) and mean distance points were also calculated for each activity group. SD ellipses are centred on their mean distance points and represent the geographical distribution trend, summarizing users' reported location dispersion and orientation. All spatial analyses were performed in QGIS (v3.22.4 LTR).

3. Results

3.1. Descriptive statistics

Gender distribution was similar (Female: 50.1% - Male: 49.3%) (Figure S1 in supplementary materials). Concerning the *age group*, adults (25–64 years) dominated (69.7%), followed by senior users (65 and over) (21.2%). Regarding *education level*, users with Master's (31.9%) and Bachelor's (27.9%) degrees dominated. As for *distance willing to travel to locations*, 37.3% of users stated that they travel 10 km and more, while 24.3% travelled between 4 km and 6 km. Less than 25% of the users engaged in environmental activities, and 4.1% participated at least once a week. Regarding the *frequency of visits*, most users visited every month (36.1%) or at least once every six months (29.4%), with only 1.3% performing a daily visit. *Physical* and *Social activities* showed the highest relevance for users, with 66.8% and 67.9% of the users classifying them as relevant to highly relevant (Fig. 2c and d respectively), well above the average values (Fig. 2f). *Cultural activities* come in second, with 58.8% (Fig. 2a). *Inspirational activities* showed a high percentage of users classifying them as of average relevance (35.4%) (Fig. 2b). *Spiritual activities* had the highest percentage of users (Fig. 2e), classifying them as not relevant or of low relevance (37.5%).

All independent variables showed significant differences ($p < 0.05$) in the evaluation of the performed activity for most class levels between the activity groups (Table 2). Significant differences were also found between classes for the following independent variables: *Age group*, *Frequency of engagement in environmental activities*, and *Frequency of visits*. *Distance willingness to travel* to perform natural activities showed significant differences between classes under *Social* and *Spiritual activities*. *Gender* and *Education level* showed non-significant differences between internal classes in all CES-related activities groups, except for *Gender* under *Social activities* and *Education level* under *Spiritual activities*.

Regarding *Gender*, only the *social activities* group showed significant differences between genders, with *male users* attributing it a slightly higher relevance than *female users* (Figure S2). In what concerns *Age groups*, both *young users* (18–24) and *senior users* (65–74) attribute the highest relevance to *Social activities* (Figure S3). *Young adults* (25–34) attribute high relevance to *Physical* and *Social* activities. *Adults* (35–44), *older adults* (45–54), and *young seniors* (55–64) attribute higher relevance to Physical activities. Older seniors attribute higher relevance to *Physical activities* and *Spiritual activities*. No significant differences were found between education levels and relevance attributed to each CES-related activity group, except for the group of *Spiritual activities* (Table 2). More users with *Primary education* attributed an average value to Spiritual activities when compared to users with other education levels (Figure S4). Relevance level from users with PhD degrees was more evenly distributed. As for the *Distance willing to travel for activities in nature*, significant differences between different distance intervals were only found for *Social* and *Spiritual activities* (Table 2). Regarding *Social activities*, a progressively higher number of users attribute the highest relevance to distances up to 9 km, slightly descending for distances of 10 km or more (Figure S5). For *Spiritual activities*, the number of users attributing the highest relevance to the activities fluctuates along distance, with the highest peak at the 4–6 km interval. Regarding *the engagement in environmental activities*, users engaging in environmental activities *Once a week* show no significant differences in the evaluation of the different activity groups. In contrast, other visitation frequencies show significant variations in all CES-related activities groups except for *Spiritual activities* (Table 2). Users engaging in environmental activities *Once every six months* attribute higher relevance to *Physical*, *Social*, *Cultural*, and *Inspirational activities* (Figure S6). Users engaging in environmental activities *Every day* further attribute high relevance to *Physical activities*, while users engaging in environmental activities *Once a month* attribute high relevance to *Social* and *Inspirational activities*. As

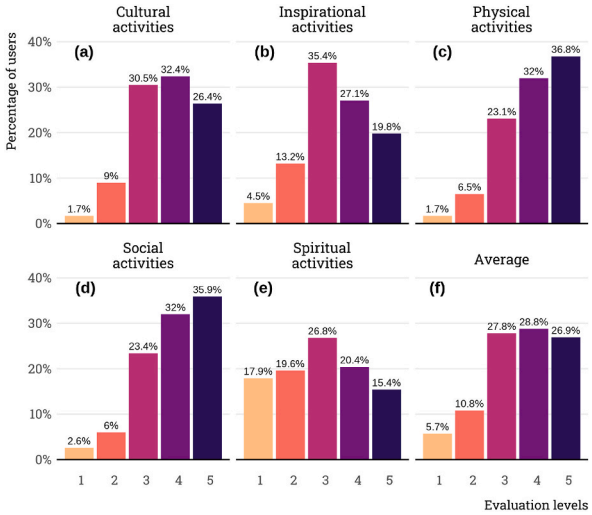


Fig. 2. Percentage of users per class of relevance (5-point Likert scale, 1 – very unimportant to 5 – very important) attributed to each CES-related activities group (a. Cultural activities; b. Inspirational activities; c. Physical activities; d. Social activities; e. Spiritual activities; f. Average for all activities).

Table 2
Kruskal-Wallis analysis results for the preference values for CES-related group activities per value of the independent variable. Cell values indicate median (1st quartile, 3rd quartile) responses. Different letters represent significant differences ($p < 0.05$) within activity groups (lowercase) and within independent variable classes per activity group (uppercase).

Gender	Cultural activities	Inspirational activities	Recreational activities	Social activities	Spiritual activities	K–W
Female	4 (3,4) c|-	3 (3,4) a|-	4 (3,5) bc|-	4 (3,5) b|B	3 (2,4) d|-	$p < 0.05$
Male	4 (3,5) c|-	3 (3,4) a|-	4 (3,5) b|-	4 (3,5) b|A	3 (2,4) a|-	$p < 0.05$
Other	4.5 (3.75,5)-|-	3.5 (2.75,4.25)-|-	4.5 (4,5)-|-	4 (3.5,4.25)-|AB	3.5 (2.5,4)-|-	n.s.
Prefer not to say	2.5 (2,3.25)-|-	3.5 (2.5,4)-|-	3 (2.75,3.5)-|-	3.5 (3,4)-|AB	2.5 (1.75,3.5) -|-	n.s.
K–W	n.s.	n.s.	n.s.	$p < 0.05$	n.s.	
Age group	**Cultural**	**Inspirational**	**Recreational**	**Social**	**Spiritual**	**K–W**
18 to 24	3 (3,4) a|AB	3 (3,4) a|ABC	4 (3,5) ab|AB	4 (3,5) b|B	2 (1,3) c|A	$p < 0.05$
25 to 34	4 (3,4) d|AB	3 (2.75,4) a|A	4 (3,5) b|A	4 (3,5) b|AB	2 (1,3) c|AB	$p < 0.05$
35 to 44	4 (3,4) c|A	3 (3,4) a|AB	4 (3,5) b|AB	4 (3,5) bc|AC	3 (2,4) d|A	$p < 0.05$
45 to 54	4 (3,5) a|A	4 (3,4) a|BC	4 (3,5) a|AB	4 (3,5) a|CD	3 (2,4) b|AB	$p < 0.05$
55 to 64	4 (3,5) ac|AB	4 (3,4) ab|C	4 (4,5) c|B	4 (3,5) ac|DE	4 (3,4) b|A	$p < 0.05$
65 to 74	4 (3,5) a|B	4 (3,4) a|C	4 (3,5) ab|AB	4 (4,5) b|E	4 (3,4.75) a|AB	$p < 0.05$
Over 74	4 (3,5)-|AB	4 (3,5)-|BC	4 (3,5)-|AB	4 (3,5)-|E	4 (3,5)-|AB	n.s.
K–W	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	
Education	**Cultural**	**Inspirational**	**Recreational**	**Social**	**Spiritual**	**K–W**
Primary education	3 (3,5)-|-	4 (4,4)-|-	4 (3,5)-|-	4 (3,5)-|-	3 (2,3)-|AB	n.s.
Secondary education	4 (3,5) ab|-	3 (3,4) a|-	4 (3,5) b|-	4 (3,5) b|-	3 (2,4) c|AB	$p < 0.05$
Post-secondary education	4 (3,4) bc|-	3 (3,4) ab||-	4 (3,5) c|-	4 (3,5) c|-	3 (2,4) a|B	$p < 0.05$
Bachelor's degree	4 (3,5) a|-	3 (3,4) a|-	4 (3,5) b|-	4 (3,5) b|-	3 (2,4) c|A	$p < 0.05$
Master's degree	4 (3,5) c|-	3 (3,4) a|-	4 (3,5) bc|-	4 (3,5) b|-	3 (2,4) d|A	$p < 0.05$
Doctor's degree (PhD)	4 (3,4.25) ab|-	4 (3,4) ab|-	4 (3,5) a|-	4 (3,5) a|-	3 (2,4) b|AB	$p < 0.05$
K–W	n.s.	n.s.	n.s.	n.s.	$p < 0.05$	
Distance willing to travel for act. in nature	**Cultural**	**Inspirational**	**Recreational**	**Social**	**Spiritual**	**K–W**
Less than 1 km away	3.5 (3,4) c|-	3 (3,4) a|-	4 (3,5) b|-	3.5 (3,4.75) bc|AB	3 (2,4) d|AB	$p < 0.05$
1–3 km away	4 (3,4) bc|-	3 (3,4) ab|-	4 (3,5) c|-	4 (3,5) c|AB	3 (2,4) a|A	$p < 0.05$
4–6 km away	4 (3,4.25) a|-	4 (3,4) a|-	4 (3,5) b|-	4 (3,5) b|AB	3 (2,4) c|AB	$p < 0.05$
7–9 km away	4 (3,5) ab|-	4 (3,4) a|-	4 (3,5) b|-	4 (4,5) b|A	3 (2,4) c|AB	$p < 0.05$
At more than 9 km	4 (3,5)-|-	3 (3,4)-|-	4 (3,5)-|-	4 (3,5)-|B	3 (2,4)-|B	n.s.
K–W	n.s.	n.s.	n.s.	$p < 0.05$	$p < 0.05$	
Engage in environmental activities	**Cultural**	**Inspirational**	**Recreational**	**Social**	**Spiritual**	**K–W**
Not engaging in environmental activities	4 (3,4) d|A	3 (3,4) a|A	4 (3,5) b|A	4 (3,5) b|A	3 (2,4) c|-	$p < 0.05$
Every day	4 (3,5) a|AB	3 (3,5) ab|AB	4 (3,5) a|AB	4 (3,5) a|A	2 (1,3) b|-	$p < 0.05$
Once a week	4 (4,4)-|AB	3 (3,4)-|AB	4 (3,5)-|AB	4 (4,5)-|AB	4 (3,4)-|-	n.s.
Once a month	4 (3,5) ab|AB	4 (3,5) ab|B	4 (3,5) a|AB	4 (4,5) a|B	4 (3,4) b|-	$p < 0.05$
Once every six months	4 (4,5) a|B	4 (3,5) ab|AB	5 (3.25,5) a|B	5 (4,5) a|AB	3 (3,4.75) b|-	$p < 0.05$
Once a year or less	4 (3,5) bc|AB	3 (3,4) ab|A	4 (3,5) c|AB	4 (3,5) c|A	3 (2,4) a|-	$p < 0.05$
K–W	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	n.s.	
Frequency of visit	**Cultural**	**Inspirational**	**Recreational**	**Social**	**Spiritual**	**K–W**
Every day	4 (3,5)-|B	4 (3,5)-|BCD	5 (4,5)-|BCD	5 (4,5)-|BC	3 (3,4.75)-|C	n.s.
Once a week	4 (3,5) abc|B	4 (3,5) ab|C	4 (4,5) c|B	4 (4,5) ac|B	4 (3,5) b|C	$p < 0.05$

(*continued on next page*)

Table 2 (*continued*)

Gender	Cultural activities	Inspirational activities	Recreational activities	Social activities	Spiritual activities	K–W
Once a month	4 (3,5) b|A	4 (3,4) a|B	4 (3,5) b|BC	4 (3,5) b|B	3 (3,4) a|A	$p < 0.05$
Once every six months	4 (3,4) c|AC	3 (3,4) ab|D	3.5 (3,4) ac|D	4 (3,4) c|C	3 (2,4) b|B	$p < 0.05$
Once a year or less	4 (3,4) b|C	3 (3,4) a|D	3 (3,4) ab|CD	3 (2,3.25) a|C	3 (2,4) a|B	$p < 0.05$
Not engaging in this group of activities	3 (2,3) a|-	2 (1,3) ab|A	3 (3,4) a|A	NA-|A	1 (1,2) b|AB	$p < 0.05$
K–W	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	

for the *frequency of visits*, significant differences have been found regarding the relevance of activities by CES-related activities groups and frequency classes (Table 2). Daily visits (*Every day*) registered the highest number of users attributing the highest relevance associated with *Social*, *Physical*, and *Inspirational* activities (Figure S7). *Cultural* and *Spiritual activities* are divided between *once a week* and *Every day*.

3.2. Multivariate analysis

Bartlett's test results reject the null hypothesis that the data variables in the dataset are uncorrelated ($p < 0.05$), supporting the development of the FA. The number of factors per activity group sufficiently explaining data variability was calculated through a parallel analysis, resulting in 4 factors for *Cultural*, *Inspirational*, *Physical*, and *Spiritual activities* and 5 factors for *Social activities*. Fig. 3 shows the exploratory FA results, plotting the first two factors for each activity group. The exploratory FA loadings for all factors per activity group are detailed in supplementary materials in Tables S2–S6.

The exploratory FA results for *Cultural activities* (Fig. 3a and Table S2), identified 4 relevant groups of variables (factors) explaining 50.8% of the total variance of the results. The first factor, *Understanding and history* (act1+act2+act3 shown grouped in the x-axis and separated from the other variables in Fig. 3a), explains 22.4% of the variance. The second is related to *Age & education level* (sd2+sd3 shown in the y-axis, separated from the other variables in Fig. 3a) and explains 12.1% of the variance. The third factor is related to the *Distance willing to travel* to engage in the activity (geo) and explains 10.5% of the variance. The fourth factor is related to *Gender* (sd1) and explains 5.8% of the variance.

Regarding Inspirational activities, 4 relevant factors were identified, explaining 41.4% of the total variance of the results (Fig. 3b and Table S3). The first factor, *Knowledge and Learning* (act1+act2+act3 grouped in the x-axis and separated from the other variables in Fig. 3b), explain 20.1% of the variance, and factor two is related to *Gender and age* (sd1+sd2 shown in the y-axis, separated from the other variables, in Fig. 3b) explaining 12.1% of the variance. The third factor is related to the *Distance users are willing to travel to engage in the activity* (geo), explaining 5.9% of the variance.

Concerning *Physical activities*, the analysis identified 4 relevant factors, globally explaining 50.6% of the total variance (Fig. 3c and Table S4). Factor 1, *Nature quietness* and *frequency* (act1+act2+act3+act4 grouped in the x-axis and detached from the other variables, in Fig. 3c), explains 23.2% of the variance, and factor 2, *Gender and age* (sd1+sd2 shown in the y-axis, separated from the other variables, in Fig. 3c), explains 12.2% of the variance. Factor 3, *Distance willing to travel to engage in the activity* (geo), explains 9.5% of the variance, and factor 4, *Education level*, explains 5.7% of the variance.

For the *Social activities* group, 5 relevant factors were identified, explaining 41.1% of the total variance (Fig. 3d and Table S5). Factor 1 is related to the *Education level* (sd3 shown isolated in the x-axis, detached from the other variables, in Fig. 3d), explaining 10.2% of the variance, and factor 2 is related to *Gender and age* (sd1+sd2 shown in the y-axis, separated from the other variables, in Fig. 3d) and explains 9.3% of the variance. Factor 3 relates to *Meeting new people* (act3), explaining 8.1% of the variance, and Factor 4 is related to *Being with family and friends* (act1+act2) and explains 8.0% of the variance. Finally, factor 5 is related to the *Distance users are willing to travel to engage in the activity* (geo), explaining an extra 5.6% of the variance.

Considering *Spiritual activities*, 4 factors were identified, explaining 51.7% of the total variance of the data. This activity group shows similarities to the previous groups, except for *Social activities* (Fig. 3e and Table S6). Factor 1 is related to *Spirituality, values, and frequency* (act1+act2+act3+act4 grouped in the x-axis and detached from the other variables in Fig. 3e) and explains 26.7% of the variance. Factor 2 embraces *Gender and age* (sd1+sd2 shown in the y-axis, separated from the other variables in Fig. 3e), explaining 12.1% of the variance. Factor 3 is related to *Education* (sd3) and explains 6.5% of the data variance. The last factor is linked to the *distance users are willing to travel to engage in the activity* (geo), explaining an extra 6.3% of the data variance.

3.3. Spatial analysis

Fig. 4 shows the activities' spatial distribution with standard deviation (SD) ellipses. All have different spatial distributions, although all activity groups are mostly associated with the city centre, as concentration levels and centroids attest. Some activities are concentrated in the Vilnius NE area and spread along the Vilnia river, on the East side of the city, and along the northern stretch of the Neris river. *Inspirational activities* (Fig. 4b) showed a higher dispersion of preferred locations (SD ellipse 32,024 ha), with an orientation WNW-ESE. *Cultural activities* (Fig. 4a) had the second largest SD ellipse (20,866 ha), with a slightly different orientation (NW-SE).

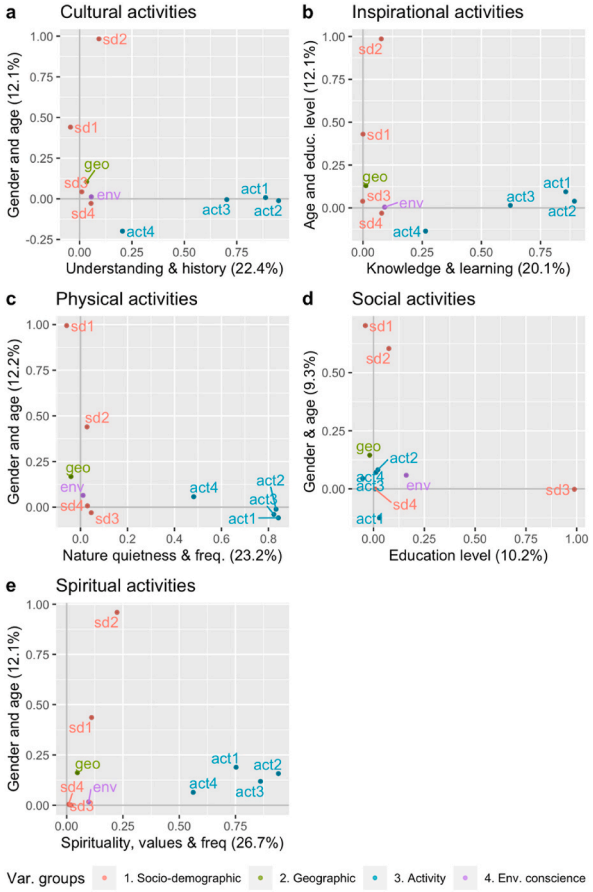


Fig. 3. FA results for the five activity groups. Different colors identify the variables aggregated into 4 groups: ***Socio-demographic variables*** (Red color – sd1: gender; sd2: age group; sd3: education level; sd4: transport type most often used; ***Geographic variables*** (Green color – geo: distance willing to take to perform activities in nature); ***Motivation variables per CES-related activities group*** (Blue color) (***Cultural activities*** - act1: to learn history and traditions; act2: to understand things; act3: to attend cultural events; ***Inspirational activities*** - act1: to develop knowledge; act2: to learn about things; act3: to enjoy uniqueness of the place; ***Physical activities*** - act1: to be close to nature; act2: to be where is quiet and in peace; act3: to relax; ***Social activities*** - act1: to be with friends; act2: to be with family; act3: to meet new people; ***Spiritual activities*** - act1: to meditate; act2: to develop spiritual activities; act3: to reflect on personal religious values; **All** – act4: frequency of activities); ***Environmental conscience variables*** (Purple color – env: frequency of engagement in environmental activities).

Physical (Fig. 4c) and *Social activities* (Fig. 4d) register similar SD ellipses in size, 9473 ha and 9448 ha, respectively, but have different distribution and orientations (WSW-ENE and SW-NE). *Physical activities* are mainly concentrated in the urban area, particularly dense over Vingis park. Small pockets of users spread all over the municipal territory, especially in the north and east areas. As for *Social activities*, the concentration is higher in the more urbanized areas, with Vingis Park also showing a relevant role, albeit lower than for *Physical activities*. *Spiritual activities* (Fig. 4e) show the smallest SD ellipse (5732 ha), with the densest areas corresponding to the SE area of the old town and the southern area of the Verkiai Regional Park.

4. Discussion

4.1. Main socio-demographic variables linked to preferences for CES-related activities groups

The results showed that socio-demographic context influences how users evaluate the types of CES-related activity groups (Table 2). *Age and gender* were the most relevant socio-demographic variables affecting CES usage, followed by *Education level* and *Distance willing to travel to engage in CES-related activities*. Other results confirm these findings, which point out personal preferences regarding CES-related activities. e.g. Ref. [30], focusing on three European cities, including Vilnius [50], in Shanghai, China [51], in Switzerland and [52] in a Pan-European study. Given that these socio-demographic variables showed up to be relevant elements for the assessed factors influencing the preferences for CES-related activities groups, they are discussed in section 4.3 in detail.

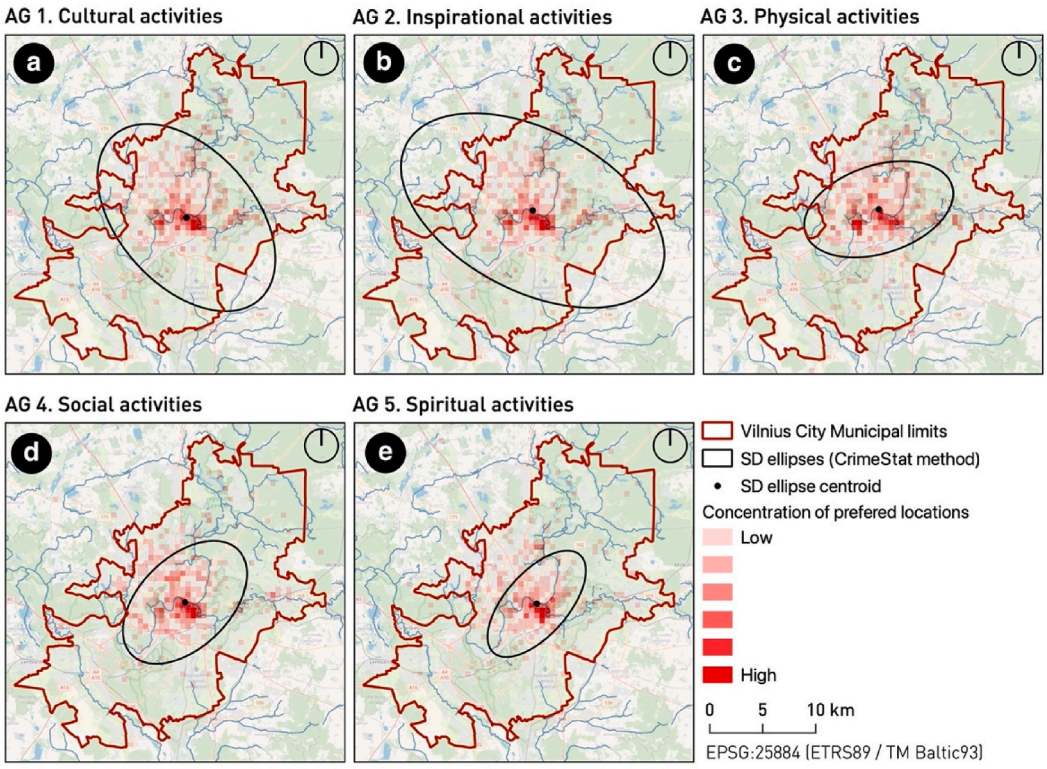


Fig. 4. Spatial distribution and concentration of activity locations by CES-related activities groups (a. Cultural activities; b. Inspirational activities; c. Physical activities; d. Social activities; e. Spiritual activities) and respective SD ellipses.

4.2. *Preferred CES-related activities groups*

Regarding the different CES-related activities groups, *Physical* and *Social activities* were the groups most valued, followed by *Cultural activities* (Fig. 2). This is in line with previous studies from different geographical regions. Social gatherings and sports were some of the most missed outdoor activities in several Italian cities during the Spring of 2020 during the COVID-19 lockdown [53]. Physical activities were also preferred in several European cities (Dresden, Liberec and Děčín), as reported by Syrbe et al. [54]. Physical activities prevailed also in Bari, Berlin, Edinburgh, Ljubljana and Malmö, followed by social activities, according to Fischer et al. [52]. Social activities were also reported as general attractiveness in Guangzhou [55] and Chengdu [56], China.

The relevance of both Physical and Cultural activities can be explained by their fundamental role in both physical and mental wellbeing, as many studies have identified (e.g., Refs. [57,58]), and as the UN has unequivocally acknowledged in their 2030 Agenda for Sustainable Development [59] and their New urban agenda [12].

4.3. *Factors influencing preferences for CES-related activities groups*

Regarding the factors influencing attributed levels of relevance to CES-related activities groups, motivations (Table 1) arise as the number one factor for CES-related activity group evaluation in all but the *Social activities* group (Tables S2–S6). This is expectable as psychological motivation, especially intrinsic motivation, can be a strong driver for action [60]. Furthermore, given that motivations are often influenced by life experience, e.g., nature experience in childhood affects preferences in leisure activities during adult years [61], socio-demographic characteristics usually come second to motivations for action.

Cultural activities, *understanding things* and *learning history and traditions* were more valued than *attending cultural events*. (Fig. 3a and Table S2). This could be partially explained by cultural events forcing users to visit on specific days and limited time slots. At the same time, heritage sites, monuments and museums have fewer access limitations. This allows for more time management flexibility, especially when enjoying free time or activities with family and children. This aligns with a study in Porto, Portugal, also a UNESCO Heritage Site, where tourists valued visits to heritage sites/monuments and museums over entertainment and cultural events [62].

For *Inspirational activities*, *learning about things* and *developing knowledge* was more valuable than *enjoying the place's uniqueness* (Fig. 3b and Table S3). Several authors mention that inspiration is often linked to a spiritual connection with nature (e.g., Refs. [63,64]). Oleynick et al. [65] stated that inspiration constitutes a motivational state. Trash and Elliot [66] defined inspiration as including three core processes: *evocation* (when a trigger stimulus evokes inspiration, i.e., an external factor stimulates the user), *transcendence* (when an individual learns of new or better possibilities), and *motivation* (when there is the will to fulfil, express, or actualize what is

newly apprehended). Considering the expressed preferences, our results suggest that individuals are more practical, being more focused on transcendence, i.e., acquiring knowledge while in nature/cultural context, rather than evocation, i.e., being inspired by nature/cultural elements.

For *Physical activities*, all preferences showed high relevance, mixing *closeness to nature*, *quiet and peace*, and *relaxation* (Fig. 3c and Table S4). The latest found to be the most common reason for visits to small UGS in a study in Shanghai by Wang et al. [50]. Similar to preferences for CES-related activities groups, the relevance of physical activities within natural spaces for wellbeing explains these results. Regarding *Spiritual activities*, the most valued motivation was *to develop spiritual activities*, followed by *self-reflection* and *meditation* (Fig. 3d and Table S5). The expressed preferences suggest that users are more practical, similar to the case with *inspirational activities*, focused on developing a spiritual or religious practice, which often is more related to a societal preference rather than engaging in introspective activities.

As previously mentioned, motivations for *Social activities* are not the main factors explaining a higher percentage of the data variance, showing up only as 3rd and 4th factor, with a clear separation in motivations between *being with friends* and *being with family* and *meeting new people*. *Meeting new people* is significant, although weakly, related to *Participation in environmental NGO activities* (Table S5), suggesting that meeting new people is at least partly associated with environmental activism. On the other hand, *Being with family* and *Being with friends* are closely related and can be seen as an expression of societal preferences. People prefer recreational activities with friends and family, especially relevant users with children. This is a common situation found in several studies on CES in urban green spaces. Kerishnan et al. [67] found that the majority of respondents in a study on pocket parks in Kuala Lumpur, Malaysia, prefer to visit the parks in a group with friends and family. Similarly, Wang et al. [50] found that meetings with friends were one of the most common reasons to visit small UGS.

Regarding the socio-demographic variables incorporating relevant factors affecting the attributed relevance for the different CES-related activities groups, *Age* and *Education level* loaded as factor 2 for relevance attributed to *Cultural activities*, loading with *Gender* as factor 2 for relevance attributed to the rest of the CES groups – *Inspirational*, *Physical*, *Social*, and *Spiritual activities*. *Age* significantly influenced green space visits in several studies, e.g., in the Greater Tokyo region, Japan [68], or Kolkata, India [58].

There are, however, divergent results in other studies. While our results showed that teenagers have a higher interest in *Social activities* when compared to other age groups, they have lower levels of interest than the other age groups for *Physical*, *Cultural* and *Inspirational activities* (Table 2). Hegetschweiler et al. [51] verified that teenagers prefer socializing and engaging in physical activities, contrary to our results.

Furthermore, our results regarding adults also tend to contradict Hegetschweiler et al. [51], which state that adults prefer more contemplative ways (in forest areas). In our work, only after 45, adults prefer *Social activities* over *Physical activities*, with *Inspirational activities* receiving lower evaluations, which can be regarded as a cultural phenomenon. *Age* was also identified as a relevant variable in the use of UGS in three European cities, including Vilnius, by Priess et al. [30], showing younger users with a higher interest in the availability of space for physical activities. In comparison, older users preferred nature, landscape, or wilderness. Furthermore, social or cultural interactions were entirely secondary for all other motivations, even for senior users, except for young adults in Vilnius, this last result being in line with our results. These differences in results from Priess et al. [30] might derive from how each survey was structured. While we asked each user for the level of relevance for the five CES-related activities groups, Priess et al. [30] asked for preference for a single activity, which does not allow for voting in different CES alternatives.

Education level was a determining factor in preferred activities in other studies, e.g., in Kisumo, Kenia [69], or Turkey [70]. *Education level* loaded as factor 4 regarding the factor analysis of *Spiritual activities* (Table S6), with a weak but significant association with *Participation in environmental NGO activities*. Considering the significant differences per education level inside the group of *Spiritual activities*, and the distribution of users per degree of relevance and education level, these results might suggest that users with higher education levels attribute less relevance to *Spiritual activities* than less educated people. Considering the combination *Age* and *Education levels* in *Cultural activities*, their combination can indicate that *Cultural activities* are more relevant to older users with higher education levels. On the other hand, considering the combination *Gender and age* in the other CES-related activities groups, *Gender* was found influential in recreational ES in several studies elsewhere, e.g., in the previously mentioned study in Kolkata, India, by Dinda and Ghosh [58]. In our case, results suggest that older male users have a particular preference for *Social activities*.

The frequency of visits was strongly linked to the evaluation of both *Physical* and *Spiritual activities* (loading in Factor 1 in both cases). It was also identified as relevant in UGS use elsewhere [68,71]. *The frequency of visits*, motivations, and satisfaction have also been reported to be associated with place attachment [72]. In our case, this suggests that *Physical* and *Spiritual activities* can be associated with higher levels of place attachment, i.e., people might visit the same places as they associate them with these particular activities. The *frequency of visits* for *Physical* and *Spiritual activities* is linked to the restorativeness mediating role. This was identified by Dentamaro et al. [73], where users associate a restorative process in their wellbeing with a higher frequency of visits.

Distance willing to travel for activities in nature significantly differed between different distance intervals for *Social* and *Spiritual activities* (Table 2). Previous studies have shown that distance is a relevant variable affecting UGS use [74]. Nilsson et al. [75] mentioned that when the distance to UGS surpasses 300 m, one in every four users quits using the UGS. However, other studies have simultaneously confirmed that users visit other UGS than the one closest to home [57]. Regarding *Social activities*, a progressively higher number of users attribute the highest relevance to distances up to 9 km, slightly descending for distances of 10 km or more (Figure S5).

For *Spiritual activities*, the number of users attributing the highest relevance to the activities fluctuates along distance, with the highest peak at the 4–6 km interval. The results for both groups of *Social* and *Spiritual activities* suggest that, similarly to the frequency of visits, users have chosen locations due to place attachment. For instance, because they fulfil their expectations, users are willing to travel considerable distances to ensure a visit to a specific location.

The results concerning socio-demographic variables highlight the need for continuous investment in human-nature analysis to enable multicultural societies to maximize and benefit from the cultural ecosystem services that urban green spaces can offer [52]. Place attachment might have a relevant role in attributed relevance, associated with *Physical*, *Social*, and *Spiritual activities*, and translated by the socio-demographic variables *Frequency of visit* and *Distance willing to travel for activities in nature*.

4.4. Elements affecting the spatial distribution of preferred locations for the CES-related activities groups

The spatial distribution of identified locations shows an aggregated pattern (Figure S8), particularly dense in the area corresponding to the city centre. This concentration does correspond to the old town area, classified by UNESCO as a World Heritage Site. This classified area, which covers less than 1% of the city's total area, aggregates 42.2% of the locations identified by the users (662 locations/km^2). Considering both the UNESCO old town area and the surrounding protection area, an area corresponding to 5.7% of the city area contains 66.6% of the locations pinpointed by the users (162 locations/km^2).

Our results confirm that the global concentration of identified locations for all activity groups in the city centre does not correspond to proximity to home. This is further confirmed by the fact that the largest percentage of users (37.3%) assume that they are willing to travel more than 10 km to engage in certain activities (Figure S1), with higher distances associated with higher levels of relevance (Figure S5). This is in line with other studies, which identify elements other than distance affecting visitation, such as users' attitude towards nature [76], proximity to retail areas [77], or UGS dimension [57,78]. Rall et al. [79] found similar results, with the density of perceived CES decreasing from the inner to the outer limits of the city, and recreational, social, and cultural services concentrated in the inner city.

This concentration corresponds to a higher offer of spaces for different CES-related activities groups, identified by Kalinauskas et al. [29], with people actively looking for recreational places in the city (e.g., Figure S9.1 to S9.14). Other areas showing a higher concentration of preferred locations include areas along the Neris (e.g., Figure S9.15 to S9.19) and Vilnia (e.g., Figure S9.20 to S9.23) rivers, areas inside the Verkiai (e.g., Figure S9.24 to S9.30) and Pavilniai (e.g., Figure S9.38 to S9.40) Regional Parks with forest areas, and the urban areas around the city centre, particularly in the western areas (e.g., Figure S9.41 to S9.42) (Fig. 1). The total area under regional parks covers 11.8% of the city area, containing 7.6% of the identified locations (9 locations/km^2). Although the percentage of points inside regional parks is quite smaller compared to the percentage associated with the UNESCO area, we can see that the concentration of locations inside protected areas is considerably larger than outside all protected areas, where 82.6% of the territory contains 25.8% of the locations (4 locations/km^2). This is relevant and beneficial for physical and mental wellbeing, considering forest areas have shown higher regenerative powers [80].

As for locations along the Neris and Vilnia rivers, river courses and adjacent areas are usually associated with a higher score as motivators for a visit [57,81,82], which explains its preference. The distribution of locations associated with *Cultural activities* suggests that cultural locations are related to the concentration of preferred locations in more urbanized areas, clearly associated with the old town area and respective protection area (e.g., Figure S9.1 to S9.14). The Locations preferred for *Physical activities* are located in the city centre, mainly in Vingis park (e.g., Figure S9.31 to S9.37). *Spiritual activities* show the smallest area of influence, with the densest areas corresponding to the SE area of the old town, with a higher concentration of religious buildings (e.g. Figure S9.9), and to the Kalvariju area (e.g., Figure S9.25), in the southern area of the Verkiai Regional Park.

The issue of distance affecting interaction with UGS is a complex one. UGS are relevant in the urban environment, especially in the densest, central areas, as mentioned in section 1. Furthermore, as the distance from the city limits diminishes, urban dwellers have other natural spaces surrounding the city as alternatives for interactions with nature [83–85], with inner UGS becoming less relevant. Simultaneously, several authors claim that wellbeing benefits from UGS tend to vanish when the UGS are outside an acceptable distance range (e.g., Refs. [86,87]). Nevertheless, our results show a different and more complex picture. The spatial distribution of the visitations shows users from peri-urban areas visiting areas in the core inner city and a higher concentration of visitation points in areas with fewer survey participants (Figure S8). This is in line with Schindler et al. [88] results, which reported that UGS visits are part of a rather complex set of activities, not directly affected by distance, but by a combination of both socio-demographic and UGS characteristics, which include – but is not restricted to – distance and size. It can also be related to place attachment associated with well-known and loved cultural and recreational locations in the city. The relation with peri-urban areas can also result from economic characteristics or restrictions, considering that lower- and middle-class families usually cannot afford real estate in CES-rich city centre. This is one of the reasons why Vilnius's city fabric is spreading, but the points of interest remain the same, concentrated in the city centre.

4.5. Uncertainties and limitations

The study targeted Vilnius inhabitants, but outside visitors also have a potentially relevant role in evaluating CES in the city (e.g., Refs. [89–91]). Future works should also consider external visitors. Another limitation was the assessment CES-related activities groups under analysis. A more detailed set of CES-related activities could provide finer detail helpful in providing relevant inputs for management. However, the decision to focus on a global set of 5 major CES-related activity groups was necessary to ensure effective participation and data management. More options would have produced a higher level of complexity in the survey, risking lower participation levels and fewer completed answers. Another aspect to consider is the fact that we specifically focused on the assessment of factors, including both socio-demographic variables and motivations. Although these motivations can be linked to wellbeing outcomes, their analysis was out of the scope of this paper. Further work should be done to assess clear wellbeing benefits associated with CES in the city, but this will imply a lengthy survey assessing a broader set of motivations and associated wellbeing benefits.

Nevertheless, despite the limitations, our work advances knowledge regarding the motivations and factors influencing recreational CES use in urban areas, particularly in the Baltic States.

4.6. Implications for management

Nature areas can be essential in shaping a city's identity [92]. Vilnius is a relevant example of this, with its large percentage of green areas contributing to its classification as one of the greenest European capitals. Vilnius has just signed the Green City Accord,[4] intending to improve the quality of life for its citizens while supporting the city's climate ambition. Vilnius aims to achieve climate neutrality through the Green City Accord by 2030. Vilnius is also implementing the Green Wave initiative,[5] aiming to plant 100,000 trees, 10 million shrubs and 300,000 vines within the next years. The goal is to improve the city's biodiversity through integration with local stakeholders. Under this line of action, it is fundamental to consider both the inhabitants' CES preferences and the city-specific context regarding UGS availability to achieve effective and sustainable planning and management of UGS [93,94].

Based on our findings, UGS planning and management need to consider the major socio-demographic variables influencing preferences for CES-related activities: *Age*, *Gender*, *Distance willing to travel*, and *Frequency of visit*. This aligns with similar results by other authors (e.g., Refs. [58,95–97]). In areas more prone to spiritual activities, with higher relevance for female users, its management must consider users' concerns, particularly regarding physical safety, which has been identified as particularly relevant for female users in other studies (e.g., Ref. [98]). Safety issues can be addressed through correct illumination and adequate vegetation coverage, properly tackling visibility and perceived safety concerns. Regarding age groups, given the especially high interest in social activities for seniors (65 and above), management should consider measures that ensure adequate and safe access for seniors and promote social interaction in UGS. UGS design should focus on age-friendly measures. Special attention should be paid to adequate pavement solutions, offering non-slippery and regular/even grounds [99], and increasing and generalizing the installation of equipment promoting socialization (e.g., benches, chess tables, and other similar equipment).

Broadleaved species for natural shadow areas in summer and solar exposure in winter should also be considered to promote climate comfort for these users. Attending to senior users' necessities is particularly relevant considering the foreseeable scenario of an ageing population [100] and a shift in weather patterns, with increasingly warmer seasons, due to climate change [101], mainly affecting seniors' physical wellbeing. Furthermore, senior users should be included in the decision-making process to ensure the creation of inclusive and senior-friendly UGS [102]. These measures contribute towards implementing the UN Healthy Ageing decade 2021–2030, defined by the World Health Organization as "*the process of developing and maintaining the functional ability that enables wellbeing in older age*" [103].

Regarding the spatial distribution of the activities, tourism growth and the protection of natural resources are complex issues for managers to balance [104,105]. One-third of protected land in the world is under intense pressure [105], by, among other factors, land use pressure, climate change, and social, political and economic limitations [106]. This is particularly relevant in the Vilnius case, considering the presence of the Pavilniai and Verkiai Regional Parks and the density of recreational locations inside their areas. Areas well known by the public for being recreational and/or natural spots tend to aggregate more users. This is especially relevant in spaces inside protected areas, which have usually been promoted as cultural/recreational/ecological areas, thus increasing the number of potential users who desire to visit and get to know and enjoy these areas.

Further studies focused on identifying hotspots of potential conflicts between recreation and conservation activities are also suggested, considering their relevance and benefits for management entities. Since *distance* was found to be a less relevant predictor for CES use, it is important to reflect on the distribution of recreational spaces, expanding their reach outside the city centre, to redistribute part of the users that tend to visit this area.

Managers should consider studying other areas with recreation potential spread across the municipal territory, which can be prepared and equipped for increased recreational use, and promote them as alternatives to existing areas under user pressure. Promotion is a key aspect, given the assessed role of distance in place identity, which might hinder an easy shift of users to new locations. According to our results, priority should be given to the southern area of the municipality. Given the relevance of physical and social activities, we suggest that new areas should always consider the installation of adequate equipment for social activities (e.g., benches, water fountains, adequate natural shelter elements), as well as for physical activities (e.g., fitness equipment for different age groups, compact sports fields, adequate for both individual and group sports).

Implementing all green elements should be considered and integrated under the Green Wave initiative. The implementation of management measures, preferably based on public participation, is fundamental to contribute towards the physical and mental wellbeing of the population, fundamental to achieve different United Nations Sustainable Development Goals (SDGs), such as goal 3 ″Good health and wellbeing" and goal 11 ″Sustainable cities and communities" [59].

5. Conclusions

This study assessed preferences and factors affecting CES usage in Vilnius, Lithuania. We identified the most relevant groups of CES-related activities for Vilnius' inhabitants. We assessed motivations and socio-demographic variables loading into main factors associated with the relevance level attributed to the CES-related activities groups. We identified the spatial distribution of the groups and

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

[5] https://vilnius.lt/en/2021/10/01/the-green-wave-is-rising-in-vilnius-with-hundreds-of-thousands-of-trees-millions-of-shrubs-and-vines/.

the main elements affecting this distribution. *Physical* and *Social activities* were the respondents' most important CES-related activities groups, with *Spiritual activities* being the less popular. Results show that, except for *Social activities*, motivations specific for each CES-related activities groups are the main drivers for action, with socio-demographic variables *age*, *gender*, *education level*, *distance willing to travel*, and *frequency of visit* showing as elements loading in the secondary factors. *Age* and *gender* are loaded as the first factor for *Social activities*, showing distinct characteristics according to the CES-related activities groups. The spatial distribution shows that the city centre contains a relevant concentration of cultural points of interest, also associated with the UNESCO World Heritage site corresponding to the Old town of Vilnius. Other locations with a high concentration of locations include areas along the rivers Vilnia and Neris, as well as the areas inside the Regional Parks of Pavilniai and Verkiai. Usage intensity creates pressure on central areas in the city and in naturally protected areas, which need to be properly assessed and addressed. UGS are under pressure from urban growth and intensification of use. Actions considering senior users are particularly needed. Recreational activities, tourism growth and the protection of natural resources are complex issues for managers to balance and need the involvement of local stakeholders, including the local population. Given the recent steps that Vilnius Municipality has taken, it is advisable and feasible to integrate many of the suggested measures into current actions being developed by the municipality. The results are relevant to municipal managers, as they allow a better understanding of users' interactions with the territory, its multifunctionality, and potential conflict areas between conservation and recreation.

Author contribution statement

Luís Valença Pinto: Analyzed and interpreted the data; Wrote the paper.

Miguel Inácio; Marius Kalinauskas; Eduardo Gomes; Paulo Pereira: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Katažyna Bogdzevič;: Conceived and designed the experiments; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

Supplementary content related to this article has been published online at [URL].

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Declaration of interest's statement

The authors declare no conflict of interest.

Appendix A. Supplementary data

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