Growing green: Exploring the drivers of citizens' participation in Italian urban and peri-urban forestation governance

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A B S T R A C T

Urban and peri-urban forests (UPUFs) are essential components of urban landscapes that offer multiple benefits to local communities, above all to those who live in large cities. This realization has fueled the interest of the scientific community in understanding citizens' attitudes and perceptions towards UPUFs, focusing on the diverse ecosystem services they provide in social and environmental terms. However, less attention has been paid to the citizens' perceptions and attitudes about UPUFs in relation to their willingness to participate in their governance. This quantitative study aims to address this gap by identifying the main factors that affect citizens' participation in UPUFs governance. Conducted in large Italian Metropolitan Functional Urban Areas, composed of a city and its commuting zone, with a population above 500,000 inhabitants, this study provides valuable insights into citizens' willingness to participate in UPUFs governance. Results indicate that citizens' socio-demographic factors (especially education, age, and income) and the frequency of visits impact their perception of UPUFs. High positive perceptions of environmental quality and low perceptions of the negative impact of UPUFs promote active participation in governance, especially among young citizens with heightened green space sensitivity, among those dissatisfied with current green space management and those advocating for effective communication campaigns. These findings can provide a practicable scientific reference for municipalities to refine their corresponding decision-making and communication, and to devise effective urban forest programs.

1. Introduction

1.1. Research background

Contemporary urban development and design increasingly press upon the need to make cities green, resilient and inclusive (World Bank, 2023a), as an imperative arising from the growing levels of urbanization and infrastructure advancement. According to the most recent World Bank data (World Bank, 2023b), around 4.4 billion people presently live in cities, or 56 % of the world's population. That figure, according to the same source, will more than double by 2050 and 70 % of global population will live in urban areas. This relentless increase in urbanization is generating a number of significant environmental problems including the deterioration of water quality, air pollution (over 70 % of greenhouse gas emissions are generated by cities), the erosion of the natural ecosystem and unsustainable pressure on natural resources (Peng et al., 2020; Xu et al., 2022; Felipe-Lucia et al., 2020).

In this context, urban and peri-urban forests (UPUFs), extending from the urban core to the most remote areas, through their ability to provide ecosystem services may represent an effective tool to mitigate and counter the challenges of climate change and urbanization by making cities greener and more resilient, improving the quality of the environment and citizens' lives (Kabisch et al., 2016). A role that has also been recognized by IPCC (Intergovernmental Panel on Climate Change) scientists, as well as being envisaged in European (Green Deal) and national (PNRR) policies. Grey and Deneke (1986) defined UPUFs as:

"Urban and peri-urban forestry is defined as the planned, integrated, and systematic approach to the management of trees in urban and peri-urban areas for their contribution to the physiological,

sociological, and economic well-being of urban society. Urban forestry is multifaceted; it deals with woodlands, groups of trees, and individual trees where dense conglomerations of people live, involves a wide variety of habitats (streets, parks, derelict corners, etc), and is concerned with a great range of benefits and problems".

Urban and peri-urban forests are part of nature-based solutions (NBS) i.e. nature inspired, and nature supported interventions aimed at creating environmental, social and economic benefits to build resilience (Scheuer et al., 2022; Tozer et al., 2020). NBS can, indeed, be considered as an effective approach to tackle increasingly frequent problems in cities such as heat waves and urban floods, thus contributing to climate change mitigation and adaptation and to the resilience and livability of cities (Kabisch et al., 2016). Through the creation of dynamic ecosystems, UPUFs guarantee a plurality of benefits including air quality improvement, microclimate regulation, CO_2 sequestration, health and well-being of citizens, and improvement and strengthening of social cohesion, to name a few (Lafortezza et al., 2017; Jankovska et al., 2010). The climate change mitigation action performed by UPUFs has been emphasized in many empirical studies. Su et al. (2022a) observed that the barrier effect created by vegetation can significantly mitigate, depending on the local conditions, air pollution, particularly by reducing the diffusion of heavy metals (PM and PM2.5) and improving air quality. Added to this is the ability of UPUFs to capture and store atmospheric carbon dioxide. For example, the study of Zhao et al. (2010) estimated that Hangzhou's urban forest (China) offsets every year as much as 18.57 % of the total amount of carbon emitted by industrial companies and contributes to storing a quantity equivalent to 1.75 times that emitted annually by industries for energy uses. This important role of forests and more generally of vegetation is confirmed by the recent study by Dewa and Buchori (2023), according to which the rapid urbanisation in the Semarang Metropolitan Region (Indonesia), and the consequent gradual process of deforestation, have led to an increase in CO_2 emissions and temperatures due to the reduction of the vegetative canopy as a heat sink. The role of urban green areas as a parameter for climate regulation and improvement has been widely studied. Cetin et al. (2022) studied the factors causing the urban heat island effect in Antalya and found that green areas contribute to "balancing the heating and absorption needs of the buildings, acting as a source of moisture, making the ground surface less warm during the day, and preventing cooling by reducing energy loss at night" (Cetin et al., 2022, p. 332). There is, in fact, a negative correlation between land surface temperature and vegetation density. A reduction in green spaces replaced by impermeable layers has led to an increase in land surface temperature in the city of Samsun (Cevik Degerli and Cetin, 2023), demonstrating that the vegetation cover of urban green spaces contributes to cooling the urban microclimate (Cetin et al., 2024). In addition, as pointed out by Zeren Cetin et al. (2023), the increase in soil temperature due to the cementification process also has a negative impact on human health, both physically and psychologically, reducing sleep and creating heat stress. In light of the benefits offered by UPUFs, it is a priority for cities to develop action plans and governance strategies for UPUFs at the urban level to respond effectively to social challenges and needs. The achievement of these ambitious objectives is possible, as emphasized by several authors, through the adoption of a multistakeholder approach to empower participatory governance (Fung and Wright, 2001; Mehmood et al., 2023) in which citizens play a central role.

1.2. Theoretical foundation and research gaps

The recognition of UPUFs as important components of urban landscapes due to the numerous benefits they offer to local communities has increased the scientific community's interest in understanding citizens' attitudes and perceptions towards UPUFs, and their influence on the willingness to participate in UPUFs governance. Several studies investigated citizens' perception of the benefits provided by UPUFs revealing

a full awareness of the plurality of ecosystem services provided in social and environmental terms (Beckmann-Wübbelt et al., 2021; Gurung et al., 2012; Takayama et al., 2014). Empirical evidence has underlined that UPUFs significantly affect the psychological and physical well-being of citizens, as well as strengthen social cohesion (Beckmann-Wübbelt et al., 2021; James et al., 2015). Nghiem et al. (2021) found that the frequency of visits of citizens to UPUFs increases positive emotions, cognitive ability and physical health. In particular, authors have revealed that emotional well-being depends on the quality of nature, on the distance to nature, the relationship with nature and the duration of the walk, and then by the opportunity to enjoy the quiet and serenity of these areas (Barona et al., 2024; Ma et al., 2019; Martin et al., 2020; Mavoa et al., 2019; Shanahan et al., 2016; Vujcic and Tomicevic-Dubljevic, 2018).

Other studies, however, reveal that citizens recognize UPUFs not only as fundamental in improving physical and mental well-being, but also in protecting the ecosystem, mitigating the effects of climate change, and reducing pollution (Nitschke et al., 2017; Gurung et al., 2012; Galati et al., 2023a). Baur et al. (2016) found that citizens attach significant importance to the management of UPUFs due to a positive perception of the positive health benefits of watersheds and more generally of habitat conservation. A conservation value which, as Wang et al. (2019) underlined, depends on the man–nature relationship, the structure of the vegetation of the green areas and the environmental context in which it is placed. Moreover, some authors have underlined that citizens' ability to recognize the benefits of UPUFs is greater the higher the level of education and social status (Gurung et al., 2012; Verlic et al., 2015). Furthermore, people's identity, including ethno-cultural identity, plays an important role in explaining their relationship with nature. Studies show that people with different ethnic and cultural backgrounds perceive the value of urban nature differently and this different perception influences in turn their involvement with UPUFs (Fischer et al., 2018). Egerer et al. (2019) find that ethno-cultural identity, as measured by language spoken, country of birth, country of origin influences the motivations and importance attributed to ecosystem services provided by the forest. For example, in the case of urban parks, the importance attributed to the psychological well-being generated by UPUFs is more prevalent among park users born abroad and who speak English as a second language than native English speakers and users born in Australia. These findings are partly corroborated by Barona et al. (2023a) who found that non-native Australians attached greater importance to UPUFs in the city of Melbourne than other respondents, and that individuals who spoke a language-other-than-English attached less importance to these areas, but those who spoke an East Asian language attached greater importance to aspects of psychological well-being than others. In other words, as the authors themselves state, "Culturally diverse communities are not homogenous, so there are sometimes nuanced and conflicting ways that these communities express their perceived value of urban nature" (Barona et al., 2023a, p.3).

As a reference to the citizens' participation in governance of UPUFs, few studies (i.e., Idris et al., 2022; Shan, 2012; Zhang et al., 2007) to date explored how the citizens' perceptions of the benefits provided by UPUFs and their environmental attitudes affect their willingness to participate in UPUFs governance by dedicating time or contributing financially, obtaining, however, conflicting results. Some empirical evidence shows that willingness to participate is influenced by citizens' recognition of the various ecosystem services offered, such as the improvement in air quality, the creation of favorable conditions for well-being, and the offer of recreational services that promote social cohesion (Idris et al., 2022; Shan, 2012; Zhang et al., 2007). This positive perception, as underlined by some authors (Liu et al., 2020; Kim et al., 2021), is significantly linked to the frequency of visits, the level of education, as well as to citizen's environmental attitude, which affects their adoption of pro-environmental behavior (Huang et al., 2021; Liu et al., 2020; Singh et al., 2021). Other studies, on the contrary, show that

citizens do not intend to dedicate time or to financially participate in UPUFs governance both due to the lack of full awareness of the plurality of ecosystem services offered and to the inability to take care of these areas in economic terms (Ajewole, 2015; Oladele et al., 2017). These results underline the importance of increasing knowledge of the role of UPUFs through educational and communication campaigns to motivate and involve citizens, thus improving the effectiveness of programs (Conway and Bang, 2014; Lamichhane and Thapa, 2012). These information/communication campaigns are also important for informing citizens about the choices made or to be made by local authorities regarding UPUFs governance. In some cases, the citizens' perception of UPUFs and the intention to become an active participant in their governance is also affected by the citizens' perceptions of an effective current governance of these areas. For example, Sanesi and Chiarello (2006) found that the citizens of Bari, recognizing the value of UPUFs, demanded a qualitative and quantitative improvement of city's green areas, expressing their interest in being informed of decisions concerning the creation of new UPUFs. Therefore, enhancing citizens' positive feelings through information campaigns that promote the ecosystem services of UPUFs and make them informed and aware of the actions taken by local government can influence their choice to participate in the governance of these areas (Janse and Konijnendijk, 2007).

A critical aspect that emerges from these studies, as underlined by Barona et al. (2022), is the scarce attention paid to the influence of socio-demographic characteristics affecting the intention of citizens to play an active role in UPUFs governance. In addition, little research has examined the role of environmental attitudes on the intention of citizens to participate in the governance of UPUFs. Furthermore, most of these studies have been carried out in the USA (e.g., Zhang et al., 2007), China (e.g., Shan, 2012), other Asian countries (e.g., Idris et al., 2022) and Southeastern Europe (e.g., Kalfas et al., 2020), while the intention of citizens to participate in UPUFs governance and the identification of the main factors affecting this decision in Italy was little explored. A sole study on this subject exists for the Italian context (Galati et al., 2023b), but it is confined to the city of Palermo in Southern Italy. The present work broadens this focus to encompass the entire Italian territory, including other large cities of the country.

1.3. Aims of the study and contribution

Aiming to close the research gap identified in the previous section, the purpose of this study is to better understand and elucidate citizens' perceptions and attitudes about UPUFs and to investigate their intention to participate in the governance of publicly managed and owned UPUFs in a participatory approach. For the purpose of this study, we consider "governance" as a process in which public and private stakeholder (governments, non-governmental bodies, community groups and individual citizens) collectively make decisions concerning UPUFs to achieve specific objectives (Barona et al., 2023b; Lawrence et al., 2013). These decisions are taken collectively and in a coordinated manner and involve the commitment of each actor in the different phases from design to planning to management, and also presuppose a monitoring phase, using public and/or private financial resources. We developed this study to answer the following research questions: "*Do perceptions of the benefits offered by UPUFs affect citizens' decisions to participate in the governance of UPUFs?*"; "*What role does the environmental attitude of citizens play in their involvement of UPUFs governance?*"; "*What are the socio-demographic features that mostly guide the choice of citizens to be involved in the governance of UPUFs in cities?*"; and also: "*Are communication and education campaigns conducted to raise awareness among citizens about environmental issues considered useful in encouraging in UPUFs process?*" and finally: "*Is the level of satisfaction with public management of*

UPUFs important for increasing this involvement?"

We focused on large Italian cities (i.e., with population above >500,000 inhabitants), which present a sound set of case studies to explore citizens' intention to participate in UPUFs governance. These cities are six -Rome, Milan, Naples, Turin, Palermo, and Genua- and cover the peninsula from North to South. In accordance with Eurostat, these cities are Metropolitan Functional Urban Areas (FUAs) that consist of the city itself and its surrounding commuting zone. Such areas, due to the high level of overbuilding and the concentration of asphalted surfaces, suffer from the urban heat island effect, i.e., a warmer microclimate than the surrounding areas. Despite the increase in the areas dedicated to UPUFs in Italy (ISTAT, 2023), people living in large Italian cities can in fact benefit, on average, of $14\,m^2$ per person of available UPUFs, against the $19.5\,m^2$ per person average when considering also minor cities. A common feature shared by these cities is the significant income disparity based on the area of living, with incomes potentially being 5 or 6 times higher between the suburbs and the city centre (source: Ministry of Economics and Finance).

To achieve the stated objectives, this study was conducted following a three-step methodological approach. First, a Principal Component Analysis (PCA) was performed to identify latent variables from the questionnaire responses. In the second step, a Seemingly Unrelated Regression (SUR) system was applied to identify sociodemographic and psychological factors influencing perceptions of various aspects of UPUFs. Finally, multivariate regression was used to estimate the potential willingness to participate in UPUF governance, simultaneously considering sociodemographic factors, psychological factors, and satisfaction with the management and communication practices of local authorities regarding UPUFs. The relationships between the different steps were further validated through a mediation analysis using the Structural Equation Modelling (SEM) approach.

This study contributes to the substantive enrichment of the literature on the main factors affecting the citizens' participation in UPUFs governance. Compared to extant corresponding empirical studies that mainly focused on people's perceptions on the benefits and possible negative aspects of UPUFs and ecosystem services, our research also simultaneously considers these perceptions together with respondents' individual environmental attitude and socio-demographic characteristics on their willingness to participate in urban forest governance. This indicates the originality and value of this study especially for decision makers as it attempts to provide accurate information to authorities governing large cities on how residents perceive urban and peri-urban forests, assess their social, environmental and cultural value, and what factors influence their decision to participate in the governance of green areas, supporting the creation of effective UPUFs programs.

This paper is structured as follows: Section 2 outlines the materials and methods used, including the underlying research framework. Section 3 presents the results of the various steps taken, along with a discussion of each outcome. The theoretical and policy implications of our findings are discussed in Section 4, and finally, Section 5 draws conclusions from the entire study, highlighting its limitations.

2. Material and methods

2.1. The research framework

Based on the literature reviewed, we hereby propose a research framework of the main factors affecting citizens' decision to participate in UPUFs governance (Fig. 1). In particular, in accordance with our aim, we focused on two distinct levels of citizen participation. The first is on people's perception of the importance of UPUFs, assuming that this can be influenced by socio-demographic and psychological factors, such as
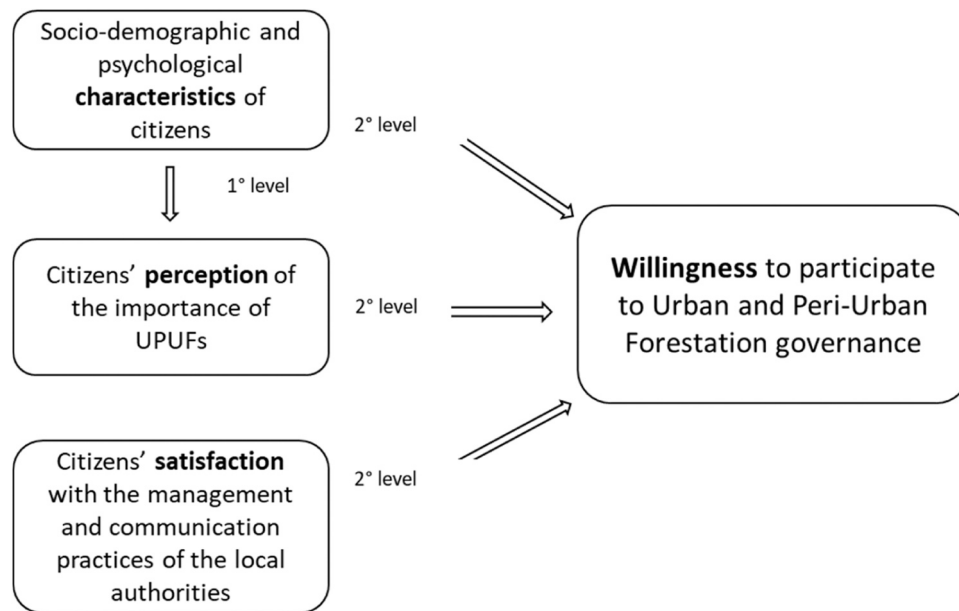
Fig. 1. Theoretical framework.

attitudes towards the environment. At the second level, we performed a comprehensive analysis to explore individuals' willingness to actively participate in urban and peri-urban forestry governance. Thus, our hypotheses are the following: a) Citizens' perceptions of the importance of UPUFs are directly affected by socio-demographic demographic factors (such as age, gender, education, income, and family size) and psychological factors (namely, environmental attitude); b) Willingness to participate to urban and peri-urban forestation governance is directly and indirectly affected by socio-demographic factors (such as age, gender, education, income, and family size) and psychological factors (environmental attitude), and directly affected by citizens' perceptions and satisfaction with the management and communication practices of the local authorities concerning UPUFs. In our theoretical framework, therefore, citizens' perceptions can also assume a role as a "mediator" between socio-demographic variables and the willingness to participate to urban and peri-urban forestation governance.

2.2. Data collection

The survey was conducted from January 2022 to January 2023 in major Italian cities with a population greater than 500,000 inhabitants. The survey, in Italian, was developed on Google Forms and spread over social media (Facebook, Instagram, and WhatsApp) using a snow-balling sampling technique and targeting a non-probabilistic sample.

Initially, we leveraged a cohort of students enrolled at the University of Milan and Palermo. They disseminated it extensively within their social networks, encouraging further distribution of the questionnaire to citizens living in the 6 Italian cities with population exceeding 500,000 inhabitants. To increase the representativeness of the sample, we also enlisted the help of acquaintances living in the target cities.[1]

An initial screening question was introduced to select only respondents living inside city limits or in close proximity of a large Italian city. In so doing, we were able to gather responses also from people living in the commuting area of a Metropolitan Functional Unit Area, but also to exclude people living outside and too far from the city area, who would be less affected by UPUFs issues.

The questionnaire consisted of 47 items organized in four different sections. The complete questionnaire can be found in the Supplementary Material. The first section queried respondents' perception toward UPUFs. In particular, 26 questions, measured on a 5-point Likert scale,[2] aimed at retrieving citizens' perceptions over the pros and cons of UPUFs, and of the different roles and functions it can have (Ajewole, 2015; Jim and Chen, 2006). The second Section (5 items) explored respondents' willingness to take part in urban and peri-urban forestation programs, in terms of planning, management and design (Ajewole, 2015; Sanesi and Chiarello, 2006; Shan, 2012). This section also included items to explore respondents' feelings towards informative awareness campaigns that also aim at increasing social engagement and citizen and citizen satisfaction with UPUFs management. The third section collected responses related to individuals' relationship with the environment, in particular, 10 items extracted from the New Environmental Paradigm (NEP) scale (Dunlap, 2008) were introduced and adapted to quantify respondents' environmental attitudes. It consists of a series of statements to which participants must express their level of agreement or disagreement, allowing for a score that reflects their ecological commitment. Five statements are positively worded, expressing a favorable view towards environmental conservation and sustainability. Respondents who score higher in these responses express concern and sensitivity towards environmental issues, and we can define them as "conscious" of environmental issues. The other five items are negatively worded, indicating a less favorable view towards environmental concerns and we can define them as "negationists". Among the numerous scales used to measure environmental attitudes, the choice of the NEP scale was made due to its recognized structural validity (Cruz and Manata, 2020) and the limited number of items in respect to other scale, considering the presence of many other questions in the

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[1] Like all snowball samples, we did not have total control over the respondents within the sample, nor do we have certainty that all respondents actually live in the 6 major Italian cities. However, we rely on the evidence that responding to a questionnaire takes time and therefore it is unlikely that people who do not correspond to the required target would still want to respond to the questionnaire.

[2] The choice of the number of responses on the Likert scale is a widely debated topic in the literature that remains unresolved. Specifically, there is a debate on whether to prefer the 5-point scale or the 7-point scale (two of the most cited works here: Dawes, 2008; Taherdoost, 2019). We opted for the 5-point scale to match the original version on the Likert scale and to ease respondents' cognitive tasks.

questionnaire.

The fourth and last section of the survey was dedicated to the collection of respondents' socio-demographic data: age, gender, family size, education, and income, and how often one visits a UPUFs. Table A1 in Appendix presents the questions of the first three section of the questionnaire used in the analysis and their characteristics.

2.3. Methodological aspects

This analysis was conducted following a three-step approach. In the first step, seven principal component analyses (PCA) were performed using SPSS v.28 on the items included in the first section of the survey - perception toward UPUFs- with the aim to reduce the number of metric variables, modelling the existing covariation among them as a function of latent constructs and preserving the common information of the original variable. Since the questionnaire items largely concern perceptions and opinions and as such could be interpreted subjectively, PCA could also be useful in addressing this issue. Indeed, PCA reducing the dimensionality of the data helps to distill the essential information from the responses, thus potentially minimizing the influence of subjective factors. Moreover, revealing shared themes among respondents, this methodology allows to focus on the aspects of the responses that are more consistent across individuals, potentially reducing the impact of idiosyncratic viewpoints.

In particular, five different PCAs were conducted on the questions that measured citizens' perceptions of the different alternative roles and functions of UPUFs following the item grouping scheme of Jim and Chen

suspicion or evidence of correlation among the error terms of different equations, and it enables simultaneous and more accurate estimation when dealing with interconnected equations representing diverse aspects of a complex system. More in detail, five different equations were estimated, one for each factor obtained from the PCA analysis: Microclimate, Environmental Quality, Environmental Function, Recreation and Landscape, Negative Impact. Each regression specification considered as independent variables respondents' socio-demographic characteristics and the two factors (negationist and conscious) obtained from the factor analysis performed on the NEP scale. Estimates were carried out using Stata v. 17 with the SUREG command. In this way, the five dependent variables of the system of linear equations share the same error structure and the simultaneous effect of the factors obtained from the PCA on the variables of interest can be estimated. The general specification of the model is given by:

$$Y_{nk} = \sum_{s=1}^{7} X_{nks}\theta_{ns} + \varepsilon_{nk} \tag{1}$$

where Y_{nk}, with $k=1,...5$, is one of the five factor loads identified from the PCA for individual n. X_{nks} with $s=1,...8$ is a vector containing five socio-demographic variables and two factor loads identifying the attitude towards the environment for individual n; θ_{nks} is the corresponding regression coefficient; ε_{nk} is the error term on individual n in regression equation for Factor k. The empirical specification for each of them is given by the following equations:

$$Y_{Microclim.} = f\left(X_{age}, X_{education}, X_{income}, X_{family\ size}, X_{frequency}, X_{gender}, X_{NEP\_negat}, X_{NEP\_conscious}\right)$$

$$Y_{Env.qual.} = f\left(X_{age}, X_{education}, X_{income}, X_{family\ size}, X_{frequency}, X_{gender}, X_{NEP\_negat}, X_{NEP\_conscious}\right)$$

$$Y_{Env.func} = f\left(X_{age}, X_{education}, X_{income}, X_{family\ size}, X_{frequency}, X_{gender}, X_{NEP\_negat}, X_{NEP\_conscious}\right)$$

$$Y_{Recr.landsc.} = f\left(X_{age}, X_{education}, X_{income}, X_{family\ size}, X_{frequency}, X_{gender}, X_{NEP\_negat}, X_{NEP\_conscious}\right)$$

$$Y_{Neg.Impct} = f\left(X_{age}, X_{education}, X_{income}, X_{family\ size}, X_{frequency}, X_{gender}, X_{NEP\_negat}, X_{NEP\_conscious}\right) \tag{2}$$

(2006), that is: 1) Microclimate; 2) Environmental Quality; 3) Environmental Function; 4) Recreation and Landscape; 5) Negative Impact. Then, the sixth PCA was conducted on the items belonging to the NEP scale that measured individuals' environmental attitudes. Lastly, the seventh PCA was conducted on the items regarding respondents' willingness to participate in urban and peri-urban forestation governance (planning, management, project design). Table 1 shows the summary of the PCAs carried out.

The first five factors obtained from the PCA on respondents' perceptions of UPUFs were used as dependent variables in the second step of our approach, where a Seemingly Unrelated Regression analysis (SUR) was conducted. The SUR model (Zellner, 1963) is a generalization of a linear regression model consisting of a system of more than one equation, where the error terms of these equations are contemporaneously correlated across the equations for one individual, but uncorrelated across individuals. This is especially useful when there is a

Where X_{age}, $X_{education}$, X_{income}, $X_{family\ size}$, X_{gender} are the socio-demographic variables for respondent n; $X_{frequency}$ is the respondent's frequency of going to UPUFs; $X_{Nep\_negationists}$ and $X_{Nep\_conscious}$ are two factor loads identified from the PCA and reflect a respondent's negationist or consciousness components of the NEP scale.

Finally, we conducted a linear regression analysis using as dependent variable the factor regarding respondents' potential willingness to take part in urban forestation projects and using a combination of socio-demographic variables and factors for each respondent. In this regression we add as regressors also the importance of information campaigns on environmental issues to raise citizens' awareness and involve them in UPUFs management processes ($X_{communication}$) and the satisfaction with the current management ($X_{management}$).

The estimated regression is given by the following equation:

$$Y_{will.\ to\ part.} = f\left(X_{age}, X_{education}, X_{income}, X_{fam.size}, X_{frequency}, X_{gender}, X_{Nep\_negat}, X_{Nep\_conscious}, Y_{climate}, Y_{quality}, Y_{Famb}, Y_{FRice}, Y_{Neg}, X_{communication}, X_{management}\right) \tag{3}$$

Since our theoretical framework suggests that there could be an intermediary effect between sociodemographic and psychological

Table 1
Scheme of all the PCAs performed.

Latent construct	PCA performed for:	N. of variables for each PCA performed*
Perception of the benefits/disadvantages of UPUFs	1) Microclimate 2) Environmental Quality 3) Environmental Function 4) Recreation and Landscape 5) Negative Impact	1) Six variables 2) Three variables 3) Five variables 4) Six variables 5) Six variables
Environmental Attitude	6) Positive and Negative Environmental Attitude	6) Ten variables
Willingness to participate	7) Willingness to be involved in urban and peri-urban forestation governance	7) Three variables

* More details on the variables can be found in Table 3

characteristics of citizens, their perceptions regarding UPUFs and their willingness to participate to urban and peri-urban forestation governance, with perceptions being intermediary variables, we ran a mediation analysis that specifically explores the intermediary effect of each perception considered. The mediation analysis is developed within the Structural Equation Modelling (SEM) using Stata v. 17 with Medsem command and is performed considering the nine different independent variables (age, education, income, household size, frequency, gender, negationist, consciousness) and the five factors measuring perceptions as mediators. Each path combination between the independent variables, the mediator variables, and the dependent variable (i.e., one's willingness to participate to urban and peri-urban forestation governance) is tested using the Sobel's and Montecarlo tests (Mehmetoglu, 2018).

From an operational perspective, the development of our work is represented in the diagram in Fig. 2, where the steps followed to achieve the set objectives are outlined.

3. Results and discussion

3.1. Sample description

We collected a sample of 468 citizens over the age of 18. Table 2 reports sample characteristics and compares them with the corresponding target population that consists of all adults living in the six cities with more than 500,000 inhabitants, which amounted to a total of 5.8 million in 2022 and represent 12 % of Italian adult population

(ISTAT, Population Census). Despite being a snow-balling sample and not particularly large, results indicate that the sample is quite representative of the target population especially in terms of age and gender. Other sociodemographic characteristics such as Household size and Education were quite atypical. Regarding income, the sample consists of nearly half of respondents with low to moderate-low incomes and a significant group of respondents with high incomes (22.6 %), while in terms of frequency, 64 % of them declare to visit green areas at least once a week.

The descriptive analysis of data related to the perceived importance, i.e., the pros and cons, of ecosystem services offered by UPUFs (see Tables A2 and A3 in Appendix) show that the benefits related to the regulatory function of "microclimate" ("O$_2$ release", "Shading" and "CO$_2$ sequestration" are considered important or very important by 94 %, 89.8 % and 89 % of respondents respectively) and the environmental quality ("Air pollutant absorption", 90 %) of the UPUFs turn out to be the most important, followed by individual benefits (i.e., "Opportunities to know and contact nature", 83 %, and "Place of recreational activities", 80.8 %). Less relevant are, instead, the landscape issue and aesthetic benefits (i.e., "Screening undesirable views", 60.5 %, and "Demarcation of landscapes", 6.8 %). When it comes to the drawbacks, the highest concern is "Attracting insects or pests" (22 %), followed by "Management costs" (20 %) .

With regard to the citizens' willingness to participate in the governance of UPUFs (Table A4 in Appendix) as shown by the answers, most respondents are more willing to plan (23 % declare to be very willing) and less willing to be involved in the design (17.7 %) and management (15.4 %), while the rating of current management of UPUFs in their city is very low (36 % declare it to be insufficient, and only 4.1 % declare it to be very good). The survey also reveals the fundamental need for clear and compelling information campaigns on environmental issues to raise citizens' awareness and involve them in UPUFs management processes (60 % declare it to be very important). Regarding the attitude towards the environment (Table A1 in the Appendix), the positively worded statement that gathered the highest consensus is "*Humans are severely abusing the environment*", while the negatively worded statement with the highest average score is "*The idea that we will experience a major ecological catastrophe if things continue on their current course is a misguided nonsense*".

3.2. Principal component analyses

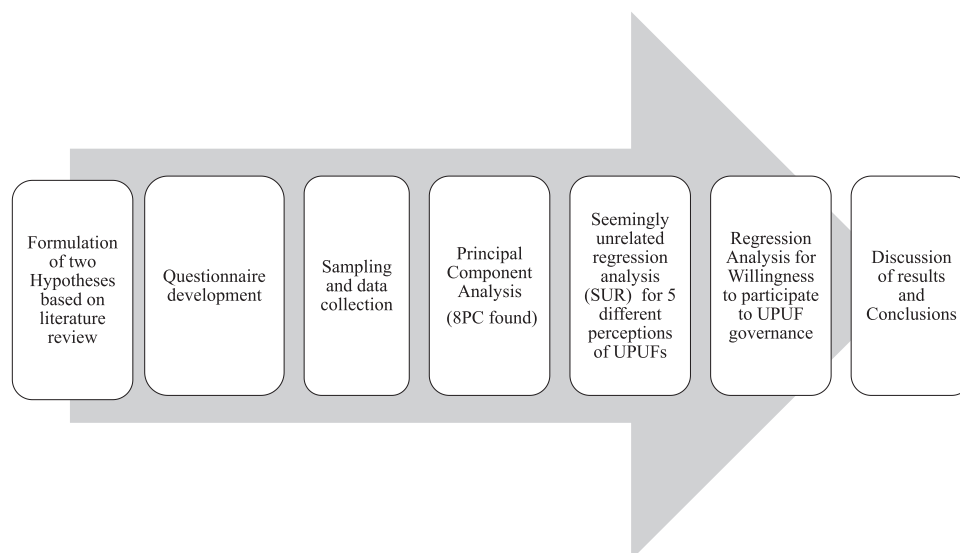This section presents the outcomes of the first five PCAs carried out

Fig. 2. Research workflow diagram.

Table 2
Sample characteristics and comparison with the target population.

Variable	Category	N.	%	population in cities >500.000* (%)
Age	18–24	47	10.0	*5.8*
	25–34	84	18.0	*13.3*
	35–44	75	16.0	*15.1*
	45–54	119	25.4	*19.1*
	55–64	113	24.2	*18.1*
	65–74	23	4.9	*13.3*
	> 75	7	1.5	*15.3*
	Total	*468*	*100.0*	*100.0*
Gender	Male	209	44.7	*47.1*
	Female	259	55.3	*52.9*
	Total	*468*	*100.0*	*100.0*
Education	Primary school/ No ed.	2	0.5	*12.4*
	Middle school	38	8.1	*22.8*
	Secondary school	167	35.7	*42.7*
	University	192	41.0	*22.1[(a)]*
	Master or Ph.d.	69	14.7	
	Total	*468*	*100.0*	*100.0*
Household size	1 member	72	15.4	*45.0*
	2 members	96	20.5	*24.7*
	3 members	98	20.9	*15.5*
	4 members	150	32.1	*11.0*
	5 +members	52	11.1	*3.8*
	Total	*468*	*100.0*	*100.0*
Income level	<1500 €	124	26.5	*n.a*
	1500–2000 €	102	21.8	
	2001–2500 €	65	13.9	
	2501–3000 €	71	15.2	
	>3001 €	106	22.6	
	Total	*468*	*100.0*	
Frequency to visit green UPUFs	Never	4	0.9	*n.a*
	Rarely	44	9.4	
	Less than once a month	33	7.0	
	At least once a month	85	18.2	
	At least once a week	207	44.2	
	Every day	95	20.3	
	Total	*468*	*100.0*	

Source: authors' elaboration from survey data and Census data (ISTAT). The complete formulation of the questions can be found in the Supplementary Material, where the entire questionnaire is provided. *We considered the six Italian cities with more than 500,000 inhabitants. [(a)]The census data for each municipality does not distinguish between the two levels of education. n.a.: Data not available

on the perceived importance of UPUFs attributes (Table 3), as well the two PCAs on the NEP scale items (Table 4) and the PCA on citizens' willingness to participate in UPUFs governance (Table 5). These analyses were performed to decrease the number of variables while maintaining the internal consistency of the constructs collected in this survey.

Table 3 reports the results of the five different PCAs conducted on the items regarding the perceived importance of benefits and drawbacks of UPUFs. It is worth stressing that these PCAs were not exploratory, rather they were constructed following the definitions provided by the literature (Jim and Chen, 2006). In so doing, five different factors were obtained: microclimate, environmental quality, environmental function, recreation and landscape, and negative impact. The *Microclimate* factor expresses one's perceived relevance of the climatic benefits that are within the UPUFs or in the immediate surroundings. The second factor, *Environmental Quality*, mainly refers to air quality and to the area capacity to absorb noises and glare. The *Environmental Function* factor is related to the green area environmental role in terms of managing wastewater and providing a wildlife habitat to protect species. The *Recreation and landscape* factor is the most hedonistic factor, as it relates to one's pure enjoyment of the area for individual purposes as well as for

aesthetic ones. The last factor, *Negative impact*, is dedicated to the weight attributed to the area in terms of security, littering, and also insects and pests. For all factors, Table 3 below reports Cronbach α scores and the share of variance explained by the latent variable. All the PCAs are valid from a statistical point of view: the KMO is in fact always greater than 0.7, and more than 60 % of variance is always explained. In all instances, the Cronbach's alphas are always greater than 0.8, suggesting a strong internal consistency of the five factors obtained.

Table 4 below reports the result of PCA conducted on the items of the NEP scale. In this case, no restriction was imposed *a priori* on the NEP items. This analysis returned two distinct factors named, respectively, *Conscious* factor, which captures respondents' awareness of climate change and of humans' environmental footprint, as opposed to the *Negationist* one, which negates instead the environmental issue. This result is of particular importance in our study because it clearly outlines two distinct types of attitudes towards the environmental issue that can have different effects both on the perception of the importance of UPUFs and on the willingness to participate to their governance. The statistical indicators (KMO, share of variance explained, and Cronbach's alpha) are all valid and indicate a strong internal consistency of the two factors.

Finally, Table 5 shows the PCA results obtained from the three questions on the willingness to participate to UPUFs management, planning and design actions. The performed analysis identified one factor, namely, *Willingness to participate* in urban and peri-urban forestation governance.

3.3. Seemingly unrelated regression analysis: what explains the perceived importance of the different attributes UPUFs

The results of the first level of our theoretical framework (Fig. 1) are obtained by the seemingly unrelated regression (SUR) analysis -as explained in Section 2.3- and indicate which individual variables have a role in influencing citizens' perception of the different attributes of UPUFs (Table 6). Especially, education and visit frequency have prominent effects on the perceived benefits. More in detail, education has a positive and significant effect on the individuals' perceived benefits, and people with higher educational attainment are less concerned about the negative consequences of UPUFs. Some authors (Galati et al., 2023b; Gurung et al., 2012; Verlic et al., 2015) explain this result with the greater knowledge of ecosystems attributing to the strategic role of UPUFs in ecological conservation of the landscape and in reducing the degradation process of UPUFs. Furthermore, visit frequency of UPUFs has a statistically significant effect on all factors considered: the higher the frequency, the higher the perceived importance of the different functions of UPUFs and the lower the perception of the negative impact. This result supports what other authors have found according to whom the amount of exposure to nature, in terms of frequency and duration, enhances positive emotions and creates conditions for physical and psychic well-being (Nghiem et al., 2021; Vujcic and Tomicevic-Dubljevic, 2018). Our results are consistent with previous empirical studies which found that the frequency of visits to UPUFs and education level significantly influence the perception that individuals have of UPUFs (Kim et al., 2021; Liu et al., 2020).

Notably, among the socio-demographic characteristics, respondents' income moves in a direction opposite to that of education. Yet, in Italy, this result might not come as a surprise, considering that students tend to attend public high-school and universities (ISTAT, 2022) and, perhaps more importantly, considering the structurally lower than European average employment return Italian graduates (in Italy, the employment rate of graduates is 81.1 % compared to an EU27 average of 88 %, source: ISTAT, 2022). Therefore, in this scenario, one could expect that education and income do not necessarily move in the same direction. Finally, this finding can be partly explained also by the substantial variation in per-capita income within our sample, characterized by a very high proportion of low-income respondents and a quite high share of high-income respondents, suggesting a potential non-linear

Table 3

Results of PCA of perception of UPUFs benefits and drawbacks.

Factor	Items	Component Matrix of extracted factors	KMO test	% of variance	No. of components	Cronbach's alpha
Microclimate			0.825	60.9	1	0.867
	O$_2$ release	0.751				
	CO$_2$ sequestration	0.760				
	Shading	0.817				
	Lower air temperature	0.807				
	Increase relative humidity	0.794				
	Wind protection	0.750				
Environmental quality			0.682	72.6	1	0.807
	Air pollutant absorption	0.796				
	Noise abatement	0.894				
	Glare and reflection control	0.863				
Environmental function			0.802	73.8	1	0.911
	Ground water recharge	0.851				
	Wastewater management	0.860				
	Soil erosion prevention	0.860				
	Wildlife habitat	0.863				
	Species conservation	0.862				
Recreation and landscape			0.848	67.1	1	0.898
	Places for recreational activities	0.855				
	Opportunities to know and contact nature	0.840				
	Cultural and educational connotation	0.846				
	Aesthetic enhancement	0.844				
	Screening undesirable view	0.747				
	Demarcation of landscapes	0.776				
Negative impact			0.850	64.6	1	0.889
	Keeping out sunshine	0.745				
	Organic litter problem	0.840				
	Attracting insects or pests	0.820				
	Security risk (darkness)	0.845				
	Security risk (burglar access)	0.823				
	Management cost	0.743				

Note: The complete formulation of the questions can be found in the Supplementary Material, where the entire questionnaire is provided.

Table 4

Results of the PCA conducted on the NEP scale items.

Factor	Items	Component Matrix of extracted factors	KMO test	% of variance	No. of components	Cronbach's alpha
PCA Statistics			0.87	64.29	2	
Conscious						
	Ecological catastrophe imminent	0.754				
	Earth: limited resources	0.748				
	Human interference: disastrous	0.834				
	Severe environmental abuse	0.764				
	Delicate nature balance	0.681				
Negationist						
	Misguided ecological prediction	0.757				
	Economic growth benefits	0.847				
	Nature balance robust	0.834				
	Limited human impact	0.846				
	Ecological collapse skepticism	0.821				

Note: The complete formulation of the questions can be found in the Supplementary Material, where the entire questionnaire is provided.

Table 5

Results of the PCA conducted on Willingness to participate to UPUF governance

Factor	Items	Component Matrix of extracted factors	KMO test	% of variance	No. of components	Crombach's alpha
	Planning	0.925				
	Management	0.872				
	Design	0.925				

Note: The complete formulation of the questions can be found in the Supplementary Material, where the entire questionnaire is provided.

association between income and perceptions. In any case, the literature on the relationship between income and benefit perceptions of UPUFs is controversial, as shown in the recent review by Haq et al. (2021).

Contrary to our results, Tian et al. (2020) concluded that higher socio-economic status in three major cities in central China was associated with increased awareness of and willingness to pay for UPUFs

Table 6

Seemingly unrelated regression results: the effect of socio-demographic characteristics and environmental attitude on the perceived importance of the different attributes of UPUFs.

	Microclimate	Environmental quality	Environmental function	Recreation and landscape	Negative impact
Socio-demographic					
Age	0.016	0.028	−0.064**	0.023	−0.124***
	(0.03109)	(0.03130)	(0.03109)	(0.03085)	(0.02881)
Education	0.164***	0.135**	−0.07	0.161***	−0.234***
	(0.05674)	(0.05713)	(0.05674)	(0.05631)	(0.05258)
Income	−0.153***	−0.116***	−0.109***	−0.140***	0.03
	(0.03147)	(0.03168)	(0.03147)	(0.03123)	(0.02916)
Household size	−0.024	−0.036	0.009	0.036	−0.017
	(0.03616)	(0.03640)	(0.03616)	(0.03589)	(0.03351)
Frequency	0.084**	0.078**	0.065*	0.134***	−0.127***
	(0.03689)	(0.03714)	(0.03689)	(0.03661)	(0.03418)
Gender	0.017	0.051	0.086	0.05	0.355***
	(0.08977)	(0.09037)	(0.08977)	(0.08909)	(0.08318)
Environmental attitude					
Negationist	−0.007	0.047	0.024	0.026	0.281***
	(0.04577)	(0.04607)	(0.04577)	(0.04542	(0.04241)
Conscious	0.111**	0.132***	0.148***	0.130***	−0.089**
	(0.0447)	(0.0450)	(0.0447)	(0.0444)	(0.0414)
Constant term	−0.533*	−0.532*	0.426	−1.007***	1.637***
	(0.3124)	(0.3145)	(0.3124)	(0.3100)	(0.2895)
Chi-square	42.46***	34.78***	42.47***	50.02***	126.52***
BP test	1350.205***				
LR	1174.564***				

Note: Standard error in parentheses. Statistical significance: ***, 1 %; **, 5 %; *, 10 %.
GLS estimator is used. BP stands for Breusch-Pagan LM Diagonal Covariance Matrix Test for Independent Equations and testing the correctness to run the Seemingly Unrelated Regression instead of single Ordinary Least Squares. LR test is the Likelihood Ratio Test for Heteroscedasticity.

ecosystem services; yet, in their analysis, the cities under examination exhibit socio-economic and cultural backgrounds markedly distinct from those considered in our study. Another study supporting this issue is found in Korle (2023), where income, among others, is identified as one of the significant variables explaining the interest to restore urban forests. These results are specific to a developing country and not directly comparable to the context studied in this research. A study conducted in the city of Coimbra, Portugal (Pinto et al., 2021), which is culturally more similar to Italy, demonstrates that higher income levels are associated with a greater appreciation of UPUFs. However, this result is also closely linked to the age of the respondents. In line with our results, on the contrary, other analyses found that individuals with lower incomes have a higher perception of the benefits offered by UPUFs. De la Barrera et al. (2016) analyzed the metropolitan area of Santiago, Chile, by comparing municipalities with different levels of per capita income and found that in the upper-income neighborhoods observed, the valuation of UPUFs is clearly lower, being relegated to a recreational space for children and not as a meeting place for neighbors. In this instance, still, the areas examined are internally homogeneous, unlike our sample, which displays significant income disparity within them. More recently, Giannico et al. (2021), in a study on 51 European cities, found that an increase in green spaces within low-income cities leads to a notably higher improvement in perceived quality of life among citizens. Their results indicate that individuals with lower incomes tend to place greater value on urban forests.

In Italy, people with higher incomes often have more opportunities to experience and appreciate natural environments outside of urban areas. Moreover, higher-income individuals typically have more access to private green areas, and this can reduce their reliance on public UPUFs. Still, wealthier neighborhoods often have a broader range of recreational facilities that provide citizens with alternative forms of leisure and entertainment, reducing their reliance on UPUFs. In contrast, individuals with lower income levels may have fewer resources and amenities, making UPUFs a vital resource for recreation, social interaction, and overall well-being. Furthermore, our findings show that age of respondents is less determinant of one's perceived importance, as it

Table 7

Regression results.

DEPENDENT VARIABLE:	Willingness to participate	Coefficient	St. Err.
Socio-demographic			
	Age	−0.087***	(0.0318)
	Education	0.015	(0.0573)
	Income	−0.083***	(0.0317)
	Household size	0.038	(0.0365)
	Frequency	0.139***	(0.0433)
	Gender (female)	−0.174**	(0.0888)
Environmental attitude			
	Negationist	−0.029	(0.0466)
	Conscious	−0.062	(0.0470)
Perceived importance			
	Microclimate	−0.101	(0.0809)
	Environmental quality	0.244***	(0.0852)
	Environmental function	0.008	(0.0770)
	Recreation and landscape	−0.016	(0.0636)
	Negative impact	−0.134***	(0.0509)
Relation with local authorities			
	Importance of communication	0.169***	(0.0627)
	Satisfaction with public UPUFs management	−0.091**	(0.0420)
	Constant term	−0.71	(0.4409)
	F(15, 452)	7.31***	
	LinkTest:		
	- Fitted values	0.99***	(0.101)
	- Fitted values squared	−0.075	(0.198)

Note: Robust standard errors in parentheses. Statistical significance: ***, 1 %; **, 5 %; *, 10 %. Link test regresses the dependent variable on its fitted values and on its fitted values squared. If the model is correctly specified, the fitted values squared should have no explanatory power

only marginally affects the Environmental Function and the Negative Impact factors with a negative sign: in other words, older respondents are less aware of the environmental role of UPUFs, but they are also less concerned about their negative impact. From this point of view, our results corroborate what has been found in some empirical research

according to which the younger generations are more aware, informed and sensitive to environmental issues (Clayton and Karazsia, 2020; Besel et al., 2017; Leung and Chan, 2006) compared to the older generation.

The results show that gender, particularly being female, is a significant factor only for the perception of the negative aspects of urban greenery. This result can be explained by the fact that the variable "negative impact" consists of a principal component obtained by considering several responses, including those related to Security risk/darkness and Security risk/burglar access (Sonti et al., 2020; Guo, 2023). For the other "perceptions", gender is not significant.

In addition, the SUR analysis assessed the influence of citizens' environmental attitudes on the positive or negative perception of UPUFs. Results indicate that negationists perceive in a stronger way the negative impact of UPUFs, as the positive and significant regression coefficient equal to 0.281 demonstrates. The conscious factor, which denotes instead a higher environmental attitude, attributes instead a higher importance to the positive roles of UPUFs (in fact all the regression coefficients are positive and statistically significant) and a lower concern for the negative aspects, as captured by the negative regression coefficient equal to −0.089.

3.4. Factors explaining the willingness to participate in urban forestation governance

As already pointed out, our study wanted to explore which factors affect the willingness of citizens to actively participate in UPUFs governance. Results are reported in Table 7. Among the different socio-demographic variables considered, age, income and being female are inversely related to the willingness to commit effort in the governance of UPUFs, whereas higher frequency levels increase it. In other words, such willingness is higher among males, younger and less affluent respondents, and, as could be expected, among respondents who regularly attend public UPUFs. Research suggests that gender is a significant factor in forest governance participation, but its influence is complex and controversial. More in details, this result corroborates previous empirical findings according to which males, especially those who visit green spaces more assiduously, are more likely to be involved in the governance of urban and peri-urban green spaces and due to females' greater fear of carrying out specific activities in the urban and peri-urban green spaces (Galati et al., 2023b; Zhao et al., 2024). On the contrary, the result seems to contrast with Greenleaf and Ries (2020) who find that are mainly females to act as volunteers in the urban forest management, driven by the desire to gain learning experiences, and with much of the recent literature pointing to a more pronounced pro-environmental behaviour among females, compared to males, as a result of greater environmental awareness and consciousness (Teixeira et al., 2023; Gifford and Nilsson, 2014).

Also at this level, the negative effect of income on individuals' willingness to participate to UPUFs governance could be explained by different factors. First, as argued earlier, high-income individuals who live in biggest Italian cities might be less inclined to dedicate time because they have other opportunities to enjoy the natural environment, such as travelling, or in their private gardens. Then, high income individuals might face time constraints that impede them from actively participating in such initiatives. In addition, as Shao et al. (2018) stated, wealthy people are less attentive to environmental issues as they think they can deal with these issues more easily than poor people even with the adoption of responsible practices. Moreover, in line with previous estimates, citizens with higher income levels tend to perceive UPUFs as being less important, resulting in a decreased willingness to allocate time towards UPUFs design and planning. On the contrary, lower-income individuals may perceive a direct correlation between urban and peri-urban forestry improvements and their quality of life, making them more willing to dedicate time and energy to such endeavors.

Interestingly enough, the two factors of environmental attitude are never statistically significant. Environmental attitude, either negative or positive, affects the perceived importance of UPUFs, but it has no role in influencing one's actual willingness to be engaged in public activities. This result could be partially reconciled with the attitude-behavior gap theory (Terlau and Hirsch, 2015; Trentinaglia De Daverio et al., 2020), according to which individuals exhibit a positive or negative attitude towards environmental issues but fail to effectively engage in the sustainable behavior requested, given the behavioral effort needed to implement such actions.

Among the factors related to the different UPUFs attributes, a higher perceived importance as an enhancer of environmental quality positively influences respondents' willingness to participate to urban and peri-urban forestation governance. Within the perception factor, most respondents (64.82 %) strongly agree with the fact that UPUFs play an important role in absorbing air pollution. Noise abatement and glare and reflection control have been rated very important by 39.02 and 27.29 % of respondents respectively (see Table A2 in Annex). This result corroborates what was previously found by other authors, according to whom the intention of citizens to participate in UPUFs governance is mainly affected by their awareness of the role that these areas play in cities by improving the citizens' quality of life, not detecting particular differences among the Southern and Northern countries of the world (Kendal et al., 2022; Kalfas et al., 2020; Shan, 2012). As Zhang et al. (2007) stated, the intention of citizens to devote time or money in the governance of UPUFs is positively related to their positive perception of the ecosystem services offered. In other words, the increased awareness that citizens have of the ecosystem value provided by UPUFs, above all in terms of environmental benefits, significantly impacts on their intention to participate in the implementation and improvement of UPUFs (Baur et al., 2016; Soto et al., 2018). Such commitment is instead negatively affected by higher concerns for the negative aspects of UPUFs. In particular, respondents (Table A3 in Annex) are mainly concerned with insect retention (7.04 % rate this issues as very important), reduced sunshine (6.61 % rate it very important) and littering (rated as very important by 6.18 % of respondents).

It is worth noting that the *Recreation and landscape* factor, which captures the more hedonistic attributes of public UPUFs, has no role on such willingness to dedicate time as emphasized in previous studies (Idris et al., 2022). The mere enjoyment of these areas for individual purposes is not a sufficient motivation for being engaged in planning, management and design activities.

Even though the descriptive statistics reported in Table A4 in Annex indicate that there are only few respondents ready to *a priori* participate in the governance (only 23, 15.4 and 17.7 % of them are in fact very willing to join planning, management, and design initiatives), we eventually observe that willingness to participate in UPUFs governance depends on the interaction with the authority responsible. In particular, information campaigns (rated as very important by 60.6 % of respondents, see Table A4 in Annex) raise awareness and citizens' involvement in UPUFs governance activities. Communication as a tool for spreading the culture of sustainability has been underlined by numerous authors (Beckmann-Wübbelt et al., 2021; Baur et al., 2016; Gurung et al., 2012). Several authors, indeed, emphasize that communication between people, facilitator and policy makers, as different stakeholders, could have a strategic role in enhancing the positive feelings of citizens toward UPUFs and encouraging the participation of citizens (Janse et al., 2007). The recognition of the importance of these campaigns, coupled with a sense of responsibility and the belief in the collective benefits, drives individuals to actively engage in efforts to enhance and sustain UPUFs.

Conversely, there is an inverse relationship between greater satisfaction levels with the current management of urban forestry and the willingness to commit further resources and efforts. When people perceive that UPUFs is well-managed and maintained, they may feel that there is not much left to be done, leading to a decrease in their willingness to commit additional time, resources and efforts. On the

contrary, if individuals feel that the responsibility for UPUFs management is not guaranteed by authorities or organizations, they may perceive their own role as more significant. For example, Sanesi and Chiarello (2006) argued that the interest of citizens in being involved in the governance processes of UPUFs is linked to their perception of a lack of attention from local authorities in improving these areas.

Finally, as mentioned in the Methodological aspects (Section 2.3), we also conducted a SEM model to test the existence of alternative intermediary effects as well as to prove the robustness of our findings. The SEM results fully endorse the results obtained in the three steps discussed above and are available upon request. As for the mediation analysis, we observe that an intermediary effect is involved considering the perception of quality and of the negative impact of UPUFs. The other three factors (microclimate, environmental function, recreation and landscape of UPUFs) have no mediating role. The results of the mediation analysis are reported in Table A5 in Annex.

4. Implications

A number of theoretical and policy implications can be drawn from the survey findings. Firstly, our study uniquely considers perceptions, attitudes and socio-demographic characteristics, simultaneously. Demographics, in particular, had been paid little attention in past research, with the present findings stressing the importance of taking into account these features in order to guarantee their effectiveness. The deeper knowledge of these factors theoretically enriches extant literature, adding to its depth and context by specifically focusing on urban and peri-urban forest programs. It further acknowledges the growing significance of these programs in contemporary urban landscapes (Cueva et al., 2022), addressing a critical gap in understanding how citizens perceive and engage with them.

In terms of governance, and equally important to the above, the findings can practically and practicably help local authorities s by supporting their urban forestry plans and decision-making, by aligning these with citizens' values and preferences (Su et al., 2022b) and by fostering greater community ownership and support (Galati et al., 2023b). Typically, in terms of policy implications, the results of this study showed that the intention of citizens to participate in the governance of UPUFs in cities is positively affected by the information they receive from local authorities, age, level of education, perception of environmental quality and frequency of UPUFs in the city. As Northrop et al. (2022) stated, an effective UPUFs governance program must demonstrate the creation of value for the citizens who use UPUFs, and it must provide clear indications for management and governance without ignoring the dynamic component of plant systems.

The claim that citizens with a higher level of education, the youngest and those frequenting the UPUFs of cities have a positive perception of the ecosystem services provided by UPUFs, especially those related to environmental quality, and are more likely to be involved in the governance of these areas underlines the importance of the knowledge dimension. The key areas of knowledge are related to i) the characteristics and ecosystem services provided by UPUFs, ii) the role they can play in improving citizens' quality of life, not only regarding their physical health but also from an environmental and economic point of view, and iii) the possibilities of involvement as an active part in the process of participating in governance. The transfer of knowledge could take place at two complementary levels. At the first level, through the organization of school educational programs. Environmental education plays an important role in creating and consolidating the connection of individuals with nature (Sato et al., 2021), increasing the level of knowledge and exerting a positive influence on children's pro-environmental attitudes, although, as Jaime et al. (2023) point out, this is not reflected in parents' behaviour. In light of this, a second level addressed to citizens as a whole through the organization of public events which must have the function of increasing citizens' connection with nature and promoting to adopt pro-environmental behavior, as

well as improving the relationship between the various local actors and mainly between decision makers and citizens by strengthening the basis for engagement when it comes to governance issues. This could be a first step towards a reflexive governance structure based on reflexive and flexible, rather than hierarchical, approaches, and on the interaction of different actors, expert and non-expert, jointly addressing risks including environmental ones (Gulsrud et al., 2018). Furthermore, with the aim of creating or enhancing awareness among citizens of the role of UPUFs and supporting their involvement in the governance of UPUFs, local authorities could develop digital platforms, such as the Urban Forest Visual adopted in Melbourne or the Urban Forest Interactive in Australia that allow citizens to acquire information about green areas and ecosystem services provided by urban forests by engaging citizens in discussions on important challenges such as climate change (Prebble et al., 2021; Gulsrud et al., 2018).

Local authorities should, therefore, allocate resources towards the development and implementation of effective communication strategies (De Luca et al., 2022) in which, through transparent and inclusive communication, citizens are more likely to feel connected to these initiatives and know that their voices are heard and valued. In light of the results, it is possible to suggest a different degree, and perhaps nature, of citizen involvement. Local authorities can, in fact, adopt various tools which, as highlighted by Janse and Konijnendijk (2007), may range from the adoption of information campaigns and collection of information, especially aimed at those who have little awareness of the benefits of UPUFs, and up to the full involvement of experts and citizens in general, in particular those interested. Concerning the former, the organization of public events aimed at raising awareness among the population also through the presentation of good practices in other contexts, or conducting surveys aimed at understanding the degree of knowledge of the population and the importance they attach to UPUFs could contribute to increasing the degree of awareness of the environmental and social role of UPUFs. On the other hand, regarding the tools to be adopted, looking at those who want to actively engage in UPUFs governance, local authorities could take charge in supporting UPUFs programs based on the concept of "urban community forests" with the involvement of various public and private stakeholders in the decision-making processes that can help overcome some critical issues that today characterize the management of urban green areas, including the low involvement of citizens and the low priority given to these spaces by local governments. As Sullivan (2022) points out, there are various forms of involvement of the citizens in the governance of urban forests, which also vary according to the legal rights granted to local communities and the level of decentralization. In this respect, there are legal provisions for cooperation between local authorities and the population as in the case of the Community Forests in Baden-Württemberg (Germany) whose activities are regulated by the State Forests Act and an administrative regulation for community forests (Hartebrodt et al., 2005). Some examples of community forestry are the London Urban Forest Partnership formed as a public-private community-based agreement comprises a network of public and private organizations including London citizens who share an interest in the protection, growth and management of the urban forest. The community led by the Greater London Authority (local government) and the Forestry Commission (national government) involves the different members in co-planning or co-planning. Another example is the Green Macomb Urban Forest Partnership in Michigan State's Macomb County where local communities, private residents, businesses, and NGOs work together to create greater awareness among citizens of the role of UPUFs and develop UPUFs in the most urbanized areas of the county.

In addition, when crafting UPUFs programs, it is imperative to take into account various socio-demographic characteristics (Jouber, 2023) and ensure that the programs are inclusive and reflective of the diversity of the urban population (Su et al., 2022b), which is vital for long-term sustainability. As Cetin et al. (2022) point out, urban planning, as well as its design, must be rational, aesthetic and functional. In other words,

its palling and design must take into account the ecological, hence the plant species in relation to their function, social, economic, and cultural characteristics of cities. By recognizing the diversity within the urban population, authorities can better tailor their strategies to cater to the specific needs and preferences of different demographic groups (De Luca et al., 2022). In the Italian case, stemming from the empirical results, local authorities could adopt two strategies. The first of information provision (sensitization events, web sites, newsletters), aimed at adults, at people with limited knowledge on and awareness of the ecosystem services provided by UPUFs, and at those who sporadically visit green areas in the city, with the aim of creating a greater involvement with nature that could be reflected in their participation in the governance of UPUFs. A second strategy could in parallel involve young people, those more aware of the role of UPUFs and urban ecosystem management in the governance and in particular in co-planning, co-managing and monitoring, involving also other actors. This approach is essential for ensuring that UPUFs initiatives are not simply inclusive (Festa et al., 2022) but also effective in engaging citizens across the city or country (Mehmood et al., 2023). In essence, acknowledging and addressing socio-demographic disparities is key to fostering widespread participation and achieving long-term sustainability in urban forest programs, which requires both the initial enthusiasm of citizens and well-planned, adaptive, and inclusive approaches that nurture their involvement over time (Butt et al., 2021). However, as Kendal et al. (2022) point out, involvement alone does not lead to greater trust and awareness of the role of urban forests, especially if this involvement is not genuine or the processes are weak.

5. Conclusions, limitations, and future research avenues

Studies focusing on citizens' perceptions and willingness to participate in UPUFs governance are a strategic tool to support and promote an effective implementation of UPUFs programs and initiatives. Compared to previous empirical studies focusing mainly on residents' perceptions of UPUFs, this study considers the effect of these perceptions on residents' intentions to actively participate in the governance and the impact of environmental attitudes and socio-demographic characteristics. The findings of this study revealed that the citizens' educational level, age, gender and income but also the frequency of visits, influence the perception that citizens have of UPUFs. Moreover, the positive perception of the benefits offered by UPUFs and, therefore, the greater awareness among citizens of the ecosystem services offered positively affect people's willingness to be active in the governance process. Above all, this applies to young males who innately have a greater sensitivity towards UPUFs. Furthermore, this willingness grows among those who believe UPUFs are poorly managed and among those who ask for stronger communication campaigns.

Despite this research's evident contribution, it does bear some limitations that are inherent to its very methodological nature. First, the study is based on relatively small, though quite representative in terms of gender and age of the reference population, sample of respondents which suggests caution in the interpretation and generalization of the results. The least represented group of respondents corresponds to those of advanced age, and this aspect may have been caused by the method of disseminating the questionnaire, which used social media channels, thus excluding older people who do not have easy access to these options, and probably more willing to participate if retired.

Another point that would require further investigation is represented by the results obtained using income as a predictor. The income distribution in our sample was found in fact to be highly variable, suggesting a non-linear trend. Future research could consider using methodologies such as categorical regression to more accurately model this non-linearity.

With regards to the generalizability of the findings, they can strictly only be interpreted with reference to the case of large Italian cities i.e. the explicitly stated focus of this research. The findings, however, do

constitute a valid theoretical foundation and a starting point for further, focused investigation into contexts that present cultural, historical and socio-economic similarities with Italy, including, but not limited to other European, particularly Westen and Mediterranean European countries. It is further noted that care should be taken with regards to generalization, even with reference to the same country, considering that there are regional and local differences related to ethnic and cultural background. Furthermore, our results found that the environmental attitudes of citizens do not have a direct, but mediating influence on the willingness to engage in responsible behavior. Therefore, future studies should test other pro-environmental scales, or new measures that can explain the phenomenon more clearly.

Thus, future theoretical and empirical research is needed to shed light on related studies in other countries, particularly those with different attitudinal profiles. Although sociocultural and economic differences make it difficult to compare Eastern and Western countries, longitudinal research could identify common drivers and barriers to citizen participation in UPUFs projects and contribute to the full picture of "urban greening" projects from a global perspective. Moreover, considering that each city has its own uniqueness, and the characteristics of its citizens may be different, future studies could investigate citizens' different perceptions of the role of UPUFs and their intention to participate in the UPUFs governance in relation to city size and geographical area. The present study, however, sought to elucidate the potential similarities among the citizens of these cities, rather than their differences.

Another limitation is related to the snowball sampling method used which, while it has the disadvantage that it does not allow for generalization of results, relying on referral from people's personal network allows for more accurate data based on a relationship of trust with respondents. Furthermore, as several authors note, snowball sampling allows for obtaining responses from people who usually are genuinely interested in the research topic (Waters, 2015; Sadler et al., 2010).

Future research should therefore investigate which communication tools and other strategies are most effective for broader citizen engagement in UPUFs governance, including participating in urban community forest programs, and thus which factors influence the success of the adopted strategies. From this point of view, future studies should test the effectiveness of information campaigns via newsletters or the creation of informative websites and public events, including workshops, on public awareness and sensitization (Mehmood et al., 2023; De Luca et al., 2022). There is also a burgeoning need for various community engagement models and strategies (Rodrigues et al., 2022) to determine which ones are most effective in mobilizing citizen involvement in forestation efforts. These models should be designed with a keen awareness of the cultural, social, and environmental contexts within which they will operate (Devisscher et al., 2022). Such models can encompass a spectrum of strategies, including public awareness campaigns, collaborative planning processes, participatory decision-making forums, and educational outreach efforts.

The present paper further enhances the more recent research's observations on the topic, consequent to the Covid pandemic. Specifically, recent studies have demonstrated notable changes in attitudes towards urban UPUFs as a result of the pandemic. Firstly, Addas and Maghrabi (2022), and Venter et al. (2021) have indicated that the pandemic brought to light the importance of accessible UPUFs for physical and mental well-being, as people sought refuge and solace in outdoor environments during lockdowns and periods of restricted movement. According to the research conducted by Grima et al. (2020), during non-pandemic periods the UPUFs areas were mostly used for mental refreshment, followed by experience loneliness, physical activities, and fresh environment respectively; while during lockdowns and periods of restricted movement many people used urban UPUFs for spending time with relatives and friends followed by mental refreshment, and physical activities. Secondly, Venter et al. (2021) have reported that heightened awareness of public health and the need for areas that allow for social

distancing have reshaped attitudes towards urban greenery, emphasizing their role not only as recreational areas, but also as essential components of resilient and sustainable urban environments. As cities strive to build back better and create more resilient urban environments, there is growing interest in integrating green infrastructure into urban planning and development strategies. Da Schio et al. (2021) have illustrated that, in Belgium, while the value attributed to UPUFs has indeed increased during the pandemic, it was already high before, which indicates that most respondents have not significantly altered their view on nature during the COVID-19 pandemic, but that the situation has reinforced their preexisting beliefs. Ugolini et al. (2021) put forward that while the restrictions may not have changed people's basic need for urban UPUFs, they did lead to an increase in the diversity of UPUFs that were accessed – with some traveling out of town, and others relying more on tree-lined streets and urban gardens.

Concluding, we divert from our core methodological question to also highlight the inexorable need for scientific cross-disciplinary consolidation of theory, practice and governance. Our research, in the spirit that increasingly guides others across the typological spectra, bridges the technocratic questions with social and organizational ones: in our case, urban planning and forestation, with governance and public perceptions and action. However, irrespective of the explicit findings and directions derived from this research, an overarching implicit methodological recognition also arises: that of the importance of seeking answers through multiple perspectives and by resting on theoretical foundations of varied fields. Practical problems demand practicable solutions, and to break the barrier of theory towards application,

scientific research must employ all tools at its disposal. In deciding which tools to use, one should consider the bond between technical issues, social phenomena and organizational/governance potentialities. We hope and trust that our study has done just that, not only contributing significant new knowledge to an important contemporary knowledge field, but also bestowing decision makers with information that catalyzes effective implementation.

CRediT authorship contribution statement

Maria Teresa Trentinaglia: Data curation, Methodology, Writing – original draft, Writing – review & editing. **Alkis Thrassou:** Writing – original draft, Writing – review & editing. **Lucia Baldi:** Formal analysis, Supervision, Writing – original draft, Writing – review & editing. **Antonino Galati:** Conceptualization, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table A1
Questions used in the survey

Items	Scale	Mean	S.D.	Obs.
Citizens' perception of the importance of ecosystem services generated by UPUFs:	from "not at all important" (=1) to "very important" (=5)			
O_2 release	1–5	4.66	0.705	468
Air pollutant absorption	1–5	4.51	0.802	468
Shading	1–5	4.45	0.803	468
CO_2 sequestration	1–5	4.49	0.828	468
Lower air temperature	1–5	4.46	0.883	468
Opportunities to know and contact nature	1–5	4.32	0.914	468
Soil erosion prevention	1–5	4.29	1.006	468
Places for recreational activities	1–5	4.21	0.938	468
Species conservation	1–5	4.19	1.053	468
Cultural and educational connotation	1–5	4.17	0.934	468
Aesthetic enhancement	1–5	4.17	0.946	468
Wildlife habitat	1–5	4.15	1.019	468
Noise abatement	1–5	4.04	1.011	468
Ground water recharge	1–5	4.01	1.064	468
Increase relative humidity	1–5	3.97	0.974	468
Wind protection	1–5	3.84	1.063	468
Wastewater management	1–5	3.86	1.132	468
Glare and reflection control	1–5	3.73	1.085	468
Demarcation of landscapes	1–5	3.69	1.069	468
Screening undesirable view	1–5	3.7	1.133	468
Citizens' perception of the importance of negative impacts of UPUF:				
Keeping out sunshine	1–5	2.17	1.178	468
Organic litter problem	1–5	2.1	1.171	468
Attracting insects or pests	1–5	2.51	1.196	468
Security risk (darkness)	1–5	2.13	1.094	468
Security risk (burglar access)	1–5	2.18	1.146	468
Management cost	1–5	2.52	1.12	468
Do you think the current management of urban forestry in your city is	from "insufficient" (=1) to "very good" (=5)	2.3	1.247	468
Willingness to participate to the planning of urban forestry activities	from "not at all willing" (=1) to "very willing" (=5)	3.49	1.203	468

Table A1 (*continued*)

Items	Scale	Mean	S.D.	Obs.
Willingness to participate to the management of urban forestry activities	from "not at all willing" (=1) to "very willing" (=5)	3.28	1.142	468
Willingness to participate to design urban forestry activities	from "not at all willing" (=1) to "very willing" (=5)	3.29	1.213	468
Importance of information campaigns on environmental issues to raise citizens' awareness and involve them in urban green management processes	from "not at all important" (=1) to "very important" (=5)	4.47	0.796	468
Environmental Attitude:	from "strongly disagree" (=1) to strongly agree (=5)			
If things continue on their present course, we will soon experience a major ecological catastrophe	1–5	4.22	1.021	468
The earth is like a spaceship with very limited room and resources	1–5	4.14	1.038	468
When humans interfere with nature it often produces disastrous consequences	1–5	4.12	1.076	468
Humans are severely abusing the environment	1–5	4.37	1.057	468
The balance of nature is very delicate and easily upset	1–5	4.16	1.091	468
The idea that we will experience a major ecological catastrophe if things continue on their current course is a misguided nonsense	1–5	1.92	1.372	468
I cannot see any real environmental problems created by rapid economic growth. It only creates benefits	1–5	1.64	1.115	468
The idea that the balance of nature is terribly delicate and easily susceptible is too pessimistic	1–5	1.85	1.188	468
I do not believe that the environment has been severely exploited by humans	1–5	1.54	1.055	468
People who claim that the relentless exploitation of nature has brought us to the brink of ecological collapse are wrong	1–5	1.69	1.189	468

Table A2
Citizens' perception of the importance of ecosystem services generated by UPUFs (% values)

	Not important	Not so important	Slightly important	Important	Very important	Tot
O_2 release	0.64	2.13	3.41	17.91	75.91	100
CO_2 sequestration	1.07	2.77	7.04	24.09	65.03	100
Shading	1.07	2.13	7.04	30.49	59.28	100
Lower air temperature	1.92	2.56	7.25	24.09	64.18	100
Increase relative humidity	1.92	5.54	20.47	37.31	34.75	100
Wind protection	3.41	8.32	20.47	36.89	30.92	100
Air pollutant absorption	0.85	2.77	6.18	25.37	64.82	100
Noise abatement	2.35	6.82	14.71	37.10	39.02	100
Glare and reflection control	4.05	9.38	23.45	35.82	27.29	100
Ground water recharge	2.77	7.25	17.70	30.92	41.36	100
Wastewater management	4.90	7.46	20.04	31.77	35.82	100
Soil erosion prevention	2.35	4.69	11.94	23.24	57.78	100
Wildlife habitat	1.71	7.46	12.79	30.06	47.97	100
Species conservation	3.20	5.33	12.37	27.29	51.81	100
Places for recreational activities	1.49	4.48	13.22	33.26	47.55	100
Opportunities to know and contact nature	1.07	4.26	11.73	27.93	55.01	100
Cultural and educational connotation	1.28	4.26	15.99	33.05	45.42	100
Aesthetic enhancement	1.28	4.69	15.78	31.98	46.27	100
Screening undesirable view	4.48	10.87	24.09	31.34	29.21	100
Demarcation of landscapes	3.62	10.66	23.88	37.10	24.73	100

Source: authors' elaboration from survey data

Table A3
Citizens' perception of the importance of negative impacts of UPUFs (% values)

	Not important	Not so important	Slightly important	Important	Very important	Tot
Keeping out sunshine	34.97	33.05	18.12	7.25	6.61	100
Organic litter problem	37.53	34.54	14.07	7.68	6.18	100
Attracting insects or pests	22.81	32.84	22.39	14.93	7.04	100
Security risk (darkness)	33.69	36.46	17.06	8.96	3.84	100
Security risk (burglar access)	34.12	33.05	18.55	9.38	4.90	100
Management cost	18.55	36.89	24.09	14.93	5.54	100

Source: Authors' elaboration from survey data

Table A4 C
itizens' willingness to plan/manage/design, rating towards current management of UPUFs and needs for information campaigns on environmental issues (% values)

	Not at all willing=1	2	3	4	Very willing=5	Tot
Willingness to participate to the planning of urban forestry activities	7.2	14.9	22.2	32.6	23.0	100
Willingness to participate to the management of urban forestry activities	7.0	18.6	29.4	29.6	15.4	100
Willingness to participate to design urban forestry activities	9.0	18.6	24.7	30.1	17.7	100
	Insufficient=1	**2**	**3**	**4**	**Very good=5**	**Tot**
Do you think the current management of urban forestry in your city is:	36.7	21.1	23.0	15.1	4.1	100

Table A4 C (*continued*)

	Not at all willing=1	2	3	4	Very willing=5	Tot
	Not at all important=1	**2**	**3**	**4**	**Very important=5**	**Tot**
Importance of information campaigns on environmental issues to raise citizens' awareness and involve them in urban green management processes	1.3	1.5	7.0	29.6	60.6	100

Source: Authors' elaboration from survey data

Table A5
Results of mediation analysis

	Perception of…				
	Microclimate	Environmental Quality	Environmental Function	Recreation and Landscape	Negative Impact
Age	No mediation	No mediation	No mediation	No mediation	Partial mediation
Education	No mediation	Complete mediation	No mediation	No mediation	Complete mediation
Income	No mediation	Partial mediation	No mediation	No mediation	No mediation
Household size	No mediation	No mediation	No mediation	No mediation	No mediation
Frequency	No mediation	No mediation	No mediation	No mediation	Partial mediation
Gender	No mediation	No mediation	No mediation	No mediation	Partial mediation
Negationist	No mediation	No mediation	No mediation	No mediation	Complete mediation
Conscious	No mediation	Complete mediation	No mediation	No mediation	Partial mediation

Note: Mediation effect was tested after performing a Structural Equation Modelling using the Baron and Kenny approach using the medsem command by Mehmetoglu (2018), which performs the Sobel's test and the Montecarlo test. Our independent, X, variables are: Age, education, income, household size, frequency, Gender, Negationist, Conscious; the mediator variables, M, are: Perception of Microclimate; Perception of Environmental Quality; Perception of Environmental Function; Perception of Recreation and Landscape; Perception of Negative Impact; the dependent variable, Y, is the Willingness to Participate. The procedure performs three steps: 1) it estimates the path X → M; 2) it estimates the path M → Y; 3) it estimates the path X → Y. There is complete mediation when the first two steps (X → M; M → Y) are significant and the Sobel's test is also significant but Step 3 (X → Y) is not significant. Mediation is partial when all the three Steps are significant (X → M; M → Y; X → Y), and the Sobel's test is also significant. There is no mediation when either Step 1 (X → M) or Step 2 (M → Y), or both, are not significant. The complete results of this procedure are available upon request.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2024.107385.

Data Availability

Data will be made available on request.

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