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Human-forest relationship in the Budapest agglomeration: an urban-rural divide among forest visitors

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Abstract

This paper conducted 1000n survey comprising 27 questions at five urban and semi-natural sample sites to analyse the human-forest relationship in Budapest and its suburban areas. The study examines the relationship between the respondent residence types – the urban-rural divide – forest use, human-nature connectedness (HNC), environment-related well-being, and activities categorized under pro-environmental behaviour (PEB). The present study employed statistical analysis with the R statistical program. The results revealed significant differences between respondents living in Budapest, suburban areas, and rural areas. Budapest residents and suburban dwellers spend less time visiting forests but hold more positive views of Hungary's environmental status. People living in Budapest also had a significantly lower nature dependency score determined by living conditions (-) and education (+). Moreover, pro-environmental habits were slightly higher among city dwellers but lower among suburban newcomers. Education levels also proved to be a more significant variable in determining whether respondents supported green policies. A further finding indicates surveys conducted in natural settings may also influence and fortify respondents' forest valuation, HNC, and PEB.

Keywords: forest, Budapest, suburbanization, pro-environmental behaviour, human-nature connectedness

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Introduction

Natural environments serve various social functions in cities and provide fundamental ecosystem services to urban populations. Related research has increasingly addressed environmental attitudes and climate change adaptation involving nature-based solutions or green infrastructure in cities (Szkordilisz, F. *et al.* 2018; Čorejová, T. *et al.* 2021; Kolcsár, R.A. *et al.* 2022; Cerovečki, M.T. and Stiperski, Z. 2024; Pröbstl-Haider, U. *et al.* 2024). Forests within and in the vicinity of urban agglomerations have faced a larger environmental load since the COVID-19 pandemic (Weinbrenner, H. *et al.* 2021; Ciesielski, M. *et al.* 2023; Pichlerová, M. *et al.* 2023). Although some research on the environment-related urban-rural divide has

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been conducted (Arcury, T.A. and Christianson, E.H. 1993; Berenguer, J. *et al.* 2005; Yu, X. 2014; Dąbrowski, L.S. *et al.* 2022), few studies have focused on how various geographical factors, such as distance from forests and residence types, influence forest use. Furthermore, knowledge in this field is still incomplete, particularly concerning how forest use influences environment-related well-being and activities (Bowler, D. *et al.* 2010; Oh, B. *et al.* 2017). The role of forests in human-nature connectedness (HNC) and pro-environmental behaviour (PEB) is underrepresented in the literature (Häyrinen, L. and Pynnönen, S. 2020). Filling this gap is vital and contributes to the research questions in the present study on forest use in Budapest and its suburban zone. The research questions are: (1) How does residence type influence forest use habits and environmental consciousness? (2) How do residence type and forest use behaviour influence environment-related well-being and activities? (3) What is the role of forests in HNC and PEB?

Budapest and its suburban zone are vital, continuously monitored areas where the post-socialist (sub)urban transformation has been intensely analysed since the country's political transition (Barta, Gy. 1999; Kok, H. and Kovács, Z. 1999; Kovács, Z. and Tosics, I. 2014; Kocsis, J.B. 2015; Kovács, Z. *et al.* 2019; Egedy, T. *et al.* 2024). Many environmental aspects have been raised, including environmental conflicts, ecological footprint comparisons, and others (Illyés, Z. *et al.* 2016; Kovács, Z. *et al.* 2020, 2022); however, research has not addressed urban or peri-urban forest use.

Theoretical background

Environmental studies have developed various concepts to grasp the essence of the human relationship with nature and human behaviour related to the environment. Concepts like human-nature-connectedness (HNC, sometimes as "connectedness to nature") and pro-environmental behaviour (PEB) form the theoretical signposts of our study. In a psychological sense, HNC could be understood as how close humans feel towards nature and how we include our relationship to nature in our identities. Relatedly, the way humans think about nature's values and utilities also modifies the human-nature relationship (Lengieza, M.L. and Aviste, R. 2025). Under pro-environmental behaviour, we include many actions that mitigate environmental impact via consumption, mobility, energy use, green activism, or foster adaptation to environmental challenges (Lange, F. and Dewitte, S. 2019). A central issue behind these concepts is whether and how the natural environment affects our daily lives, routines, activities, and thinking, as well as our direct behaviour towards nature. Consensus in environmental psychology literature indicates that our relationship with nature impacts our environmental behaviour (Lengieza, M.L. and Aviste, R. 2025), and stronger connectedness aligns with greater engagement in PEB (Whitburn, J. *et al.* 2019). There is also evidence that socio-economic and geographical factors (place of residence) impact HNC and PEB (Macias-Zambrano, L. *et al.* 2024); however, whether and how environmental education reinforces our ties to nature and motivates PEB remains under debate (Fletcher, R. 2017).

Another theoretical concept of the present study is the human–forest relationship (HFR), which is a particular formulation of HNC since forests play a determining role in our relationship with nature. Interestingly, only a few studies address forests in this sense (Häyrinen, L. and Pynnönen, S. 2020). HFR "depicts a reciprocal relationship between humans and forests that is formed through personal experiences, life histories, as well as cultural and societal backgrounds and environmental settings" (Halla, T. *et al.* 2023). A strong HFR entails understanding the vital roles of forests that extend beyond technical and economic tools for effective sustainable forestry and address the cultural and spiritual values of forests (Ritter, E. and Dauksta, D. 2013; Hafenscher, P. and Jankó, F. 2022).

Forest functions and types must also be considered to ensure a better understanding of HFR and form our perceptions about nature. Notable differences in human utilization, attitudes, and ecosystem services exist between urban forests, semi-natural forests, and forest reserves. Urban forests are part of the urban ecosystem and are ecologically, economically, and socially essential to sustainable urban development. Consequently, their main roles are anthropocentric and include climate change acclimatization, water purification, flood control, carbon storage, and recreation services (Solomu, A.D. *et al.* 2018). Semi-natural forests, which include secondary forests, also possess these capabilities; however, biodiversity preservation or economic interests play a far more prominent role in semi-natural forests (Biró, M. *et al*. 2022). Tourists are usually banned from entering forest reserves to protect the self-regulating, natural ecosystems that are vital for gene preservation. Nevertheless, perceptions of natural forests might depend on residence locations and other factors (Lutz, A.R. *et al*. 1999).

Perceptions about forests and nature depend on numerous factors, such as residence, media consumption habits, education, quality of life, cultural heritage, and individual experiences about being in nature and climate change impacts (Halla, T. *et al*. 2023; Lengieza, M.L. and Aviste, R. 2025). A European project revealed differences in local views of forests and their impact on the quality of life between macroregional rural regions. People who live in declining but forested areas, especially in Atlantic countries, view forests as a disadvantage. In contrast, Central European and Mediterranean countries with traditional forest areas hold positive views about forests (Elands, B.H.M. *et al*. 2004). Similarly, residents in timber-dependent rural regions are more informed, concerned about forest outputs, and regard forests from a practical perspective (Goula, M. *et al*. 2015). Conversely, people in urban and non-timber-dependent rural areas are more concerned about maintaining recreational opportunities for personal use (Racevskis, L.A. and Lupi, F. 2006). Living conditions and education are also key factors in HFR (similarly in HNC and PEB). Higher socio-economic status enhances the willingness to pay for forest protection or sustainable forestry. However, in urban areas, opportunity also plays a role in the frequency and duration of forest visits (Kc, A. *et al*. 2014; Zhang, M. 2022). On the other hand, demographic and employment factors might be insignificant for HNC (Cartwright, K. and Mitten, D. 2017). Finally, exceptional events, such as bushfires, energy crises, or epidemics, also affect perceptions of forests. For instance, people visited forests more frequently but for shorter durations during the COVID-19 lockdown (Wunderlich, A.C. *et al*. 2023).

Although the literature has investigated social differences in environmental concerns, awareness, and PEB, it presents no unified method. Thus, findings are often controversial and difficult to compare (Lange, F. and Dewitte, S. 2019). For instance, Gifford, R. and Nilsson, A. (2014) found that PEB or environmental concern is usually greater among urban residents, whereas anthropocentric ecological views and sustainable practices are more common among rural people. Using a Polish sample, Dąbrowski, L.S. *et al.* (2022) also claimed that settlement type significantly influences the PEB of Generation Z. National cultural conditions are also decisive. Countries themselves may have a more pronounced effect than regions within a country. A survey in Chinese and Japanese cities found that Japanese people were satisfied with the state of the environment, while Chinese residents focused more on local problems (Yingchao, L. *et al*. 2011; see also Yu, X. 2014).

Recent research also highlights distinct factors. Some studies demonstrated that the education factor and urban-rural differences are better indicators of climate change attitudes and skepticism (Jankó, F. *et al.* 2018; Weckroth, M. and Ala-Mantila, S. 2022). However, based on a national survey in England, Alcock, I. *et al.* (2020) reported that time spent in nature counted much more than residence in PEB. DeVille, N.V. *et al*.

(2021) reinforced this assumption in a narrative review but cautioned against the lack of longitudinal studies, since personal and social factors may also be important (see also: Duroy, Q.M. 2005; Gifford, R. and Nilsson, A. 2014). Overall, the literature reveals that research on how exposure to nature affects long-term attitudes toward nature and PEB is still incomplete.

Differences within the agglomeration population may stem from migration status, i.e. whether residents are newcomers or locals. For example, wealthy newcomers expressed the strongest environmental attitudes in Idaho, suggesting that newcomers from big cities could improve the environmental state of rural areas, but their proportion was negligible compared to the low-income, poorly educated locals (McBeth, M.K. and Foster, R.H. 1994). However, this should not be the case in other neighbourhoods. Other studies used the urban gradient approach to identify varying attitudes toward urban forests but reported only slight value changes between urban and rural dwellers (Su, K. *et al*. 2022). Another open question is how suburban migration changes the environmental attitudes in urban agglomerations. Another research study from a vastly different place and time found that environmental and climate change concerns and pro-environmental norms are stronger in urban areas, independent of socio-economic status or political orientation (Larson, L.R. *et al*. 2015).

Hungarian studies also demonstrate the crucial role of socio-economic background in determining environmental awareness (Mónus, F. 2019); however, a gap between environmental concern and PEB also exists as the correlation between the two is weak (Jankó, F. *et al.* 2018). Kónya, Gy. (2016) reinforced this weak correlation by concluding that studying environmental problems shaped emotions rather than behaviour. The "justification of non-behaviour" concept highlights the gap between positive environmental concern and lack of pro-environmental behaviour, i.e. lack of actions (Kollmuss, A. and Agyeman, J. 2002). For example, one study investigating Americans and Hungarians discovered that the concept was valid for Americans, who justified their non-behaviour by dismissing individual actions as insignificant and claimed that recycling consumes more energy and creates more pollution than landfilling. Hungarians refused to justify non-behaviour despite high environmental concerns. Thus, the cognitive dissonance remained unresolved. Moreover, Hungarians had higher environmental concern and PEB, but these findings were gender-independent (Kovács, J. *et al.* 2014).

Methods

Questionnaire survey

The present study is based on a 1000n questionnaire survey conducted in forests (urban and semi-natural forests), i.e. hot spot venues with touristic-recreational relevance. More broadly, the study area is part of the designated Budapest agglomeration area with 80 settlements, which more or less covers the area of suburbanization. Our basic aim was to address forest visitors and investigate their forest attitudes. Hence, the sample could not be representative of the entire population. Furthermore, it was also methodologically significant for us to survey within forests because we believe that respondents' environmental engagement and response abilities are better if the interviews occur *in situ* (Lakkonen, A. *et al*. 2018).

Among the survey locations, two were in semi-natural forests in the Budapest surroundings, i.e. *Dobogókő* (200n, Pilis Mountains) and *Királyrét* (200n, Börzsöny Mountains). There were also three urban forest locations, one in the Buda Mountains closer to the city (200n, *Normafa*), and two on the Pest side of the Danube in outer quarters with strong local significance (*Naplás-tó* and *Farkas-erdő*, 200–200n). The paper-based survey was conducted in person with the help of BA university students, who were trained beforehand, in the autumn months of 2023.

The questionnaire included 27 questions and required about 20 minutes for respondents to complete. It covered diverse topics, but we tried to keep it brief to avoid a low response rate and interrupted fillings. Questions addressing socio-economic status were single-choice and open-ended. The 10-point Likert-scale questions were designed on Hungary's environmental state, respondents' mental and physical health, and nature dependency (connectedness). Single choice questions addressed forest-use habits on the goals, frequency, duration of, and travelling modes to forests. Another two questions focused on environmental valuation of forest use, and three focused on pro-environmental behaviour. Instead of using the travel cost method, we asked the respondents to choose from pre-given, market-based non-forest activities (in order from the cheapest to the most expensive) to determine the usefulness and enjoyment value of forest visits. Also, taking an opposing viewpoint, we asked the respondents to rate the environmental value of forests through their willingness to volunteer in forest maintenance. Finally, a group of 19 5-point Likert-scale questions addressed forest-related environmental knowledge (4 questions), the mindset about climate change (2), the support of green policy (10), or orthodox energy policy options (2).

The raw data were digitized in MS Excel, and the database was processed (filtering, categorization of open-ended questions, classification of respondents' residence types). Statistical analysis was conducted using the R statistical program.

Statistical analysis

The present study applied two grouping variables in the statistical analysis. It classified the respondents based on their situation and migration status in the Budapest area. Residence type distribution (Budapest, natives, and newcomers in the suburban zone, countryside) was highly uneven among the respondents. Still, the statistical analysis was reliable due to the vast sample size *(Table 1)*. Lines where residence was inapplicable were excluded from further analysis. The percentages of further variables were calculated separately for every residence type.

In line with our endeavours to conduct the survey *in situ* in forest locations, the second grouping variable was the location where the questionnaire was completed. Riechers, M. *et al.* (2021) also noted that landscape complexity and sense of place may influence HNC. Other explanatory variables were also used where relevant. Demographic features may affect behaviour and ideology; however, time spent in forests may have been decisive in some cases. Concerning the latter, a forest visit intensity index was calculated (*Appendix 1*).

Dependent variables were present at different scales: nominal, ordinal, Likert-scale, and numeric variables. Nominal variables were analysed with Fisher's exact test, which assesses whether the proportions of one variable are different depending on the value of the other variable. Ordinal variables were analysed with the Kruskal-Wallis H test, a nonparametric method (thus, appropriate for ordinal variables) for testing whether samples originated from the same distribution.

Variance analysis was applied to numeric variables (ANOVA). A further pairwise comparison was conducted when needed with Tukey's Honest Significant Difference test (Tukey HSD).

The 5-point Likert-scale data were examined using the special Likert-package from R (https://CRAN.R-project.org/package=likert). Here, the relevant Likert-scale question scores were summed to create a Green policy support score index (see *Appendix 1*).

Table 1. Distribution of residence types, %

Capital (Budapest)	Suburban (native)	Suburban (newcomer)	Countryside	No answer
61.13	21.76	7.12	7.91	2.08

Results

Environmental awareness and forest use

Assessment of the *environmental status of Hungary* varied widely between and within residence types. The most frequent scores on a 1 to 10 scale were 5, 6, and 7. However, 20 percent of the Budapest residents only gave a 4. At the same time, Budapest residents were the only ones who did not give less than a 4 on this question. Rural residents were the most likely to think that the environmental condition of Hungary was poor. Hungary's environmental status assessment was independent of the time and frequency of forest visits; most people scored middle values (4–6).

Relatedly, assessment of the *most serious local environmental problems* showed similarities between the residence types, as *Waste/dirt* was considered the most severe problem. In the capital and the suburb, the second most severe problem was *Air pollution*, while the third was the lack or scarcity of *Green areas*. Countryside residents thought vice versa, while they also mentioned *industry* more. Other problems received only a negligible number of votes *(Figure 1)*.

Forest activity was independent of residence type and forest visit intensity. Countryside respondents used forests for *food gathering* at a higher rate than others, but the difference was not significant. Similarly, time spent in the forest was not connected to residence type. Most noted "more than half of the free time" and "approximately half of the free time." If we consider forest visit frequency and free time activities other than forest visits together, we see that countryside dwellers visit forests to the greatest extent followed by native dwellers in the suburb (*Figure 2*). "Close to nature" activities (including implicitly forest related hiking, fishing, but also gardening etc.) were chosen to a greater extent by suburban residents, independent of whether they are native or newcomers. Third, urban habits like s*port/training* and *hobbies* showed higher rates among capital residents and suburban newcomers.

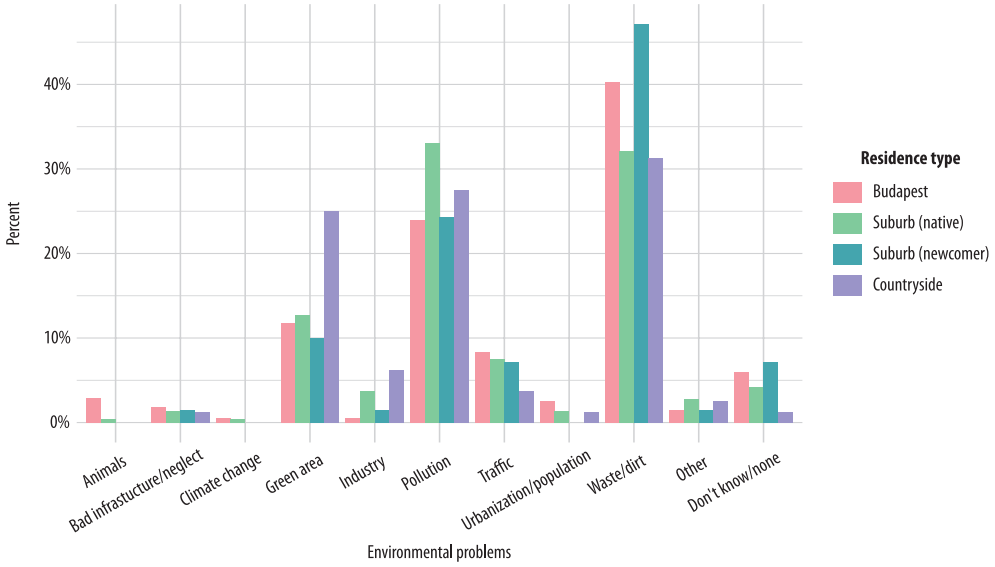

Fig. 1 The most serious environmental problems in the respondents' locality. *Source:* Authors' own elaboration.

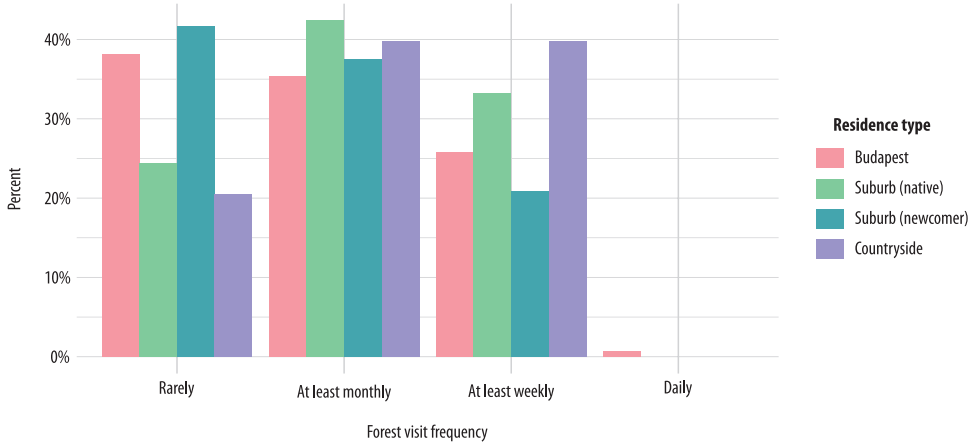

Fig. 2. The frequency of forest visits. *Source:* Authors' own elaboration.

Environment-related well-being, and nature connectedness

It was also vital for our research to address the respondents' environment-related well-being in connection with forest use and related activities. Our data showed that *mental health* was independent of residence type and *forest visit intensity*. Those living in the capital or the suburban zone (native) had better *physical health*, but *physical health* was independent of *forest visit intensity*. Many factors affect physical and mental health; however, residence type and forest visit intensity were not significant.

On the other hand, residence type was a decisive factor in nature dependency. Budapest residents had a significantly lower *nature dependency* score (ANOVA F = 22.5, p < 0.001) (*Figure 3*). *Forest visit intensity* also significantly affected the strength of nature dependency. Those who barely visited forests had a much weaker nature dependency score (ANOVA, F = 24.56, p < 0,01). However, those who rarely visited the forests were nearly as dependent on nature as those who spent much time in the woodlands.

Concerning demographic factors, nature dependency decreases with living condition improvement (Kruskal-Wallis chi-squared = 24.666, df = 9, p-value = 0.003) and increases with education level (Kruskal-Wallis chi-squared = 30.979, df = 9, p-value < 0.001). The place where people completed the questionnaire also had a significant effect. The highest nature dependency score was observable at *Dobogókő*, which is a spiritual place for many. Interestingly, *Farkas-erdő*, an urban forest, was in second place, while *Királyrét*, a semi-natural woodland, had the least nature-dependent visitors (Kruskal-Wallis chi-squared = 22.048, df = 4, p < 0.001) (*Figure 4*).

Role of forests in HNC and PEB

Some questions addressed the environmental valuation of the forests. The results showed that adding value to the forests was independent of residence type. People choose mostly the cheapest option (fitness, gym, yoga, dance, etc.) Suburban dwellers – both natives and newcomers – chose the medium-price option (having coffee or a beer with friends) at a slightly higher rate compared to capital and countryside residents. On the other hand, the frequency of forest visits had an inverse effect. Those who spent less time in forests were more willing to choose a more expensive option for a forest value equivalent. The venue

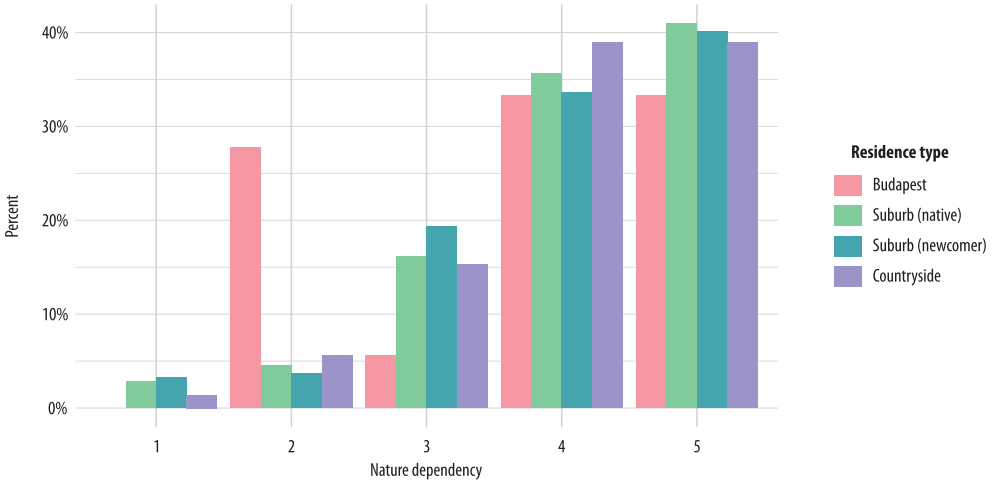

Fig. 3. Self-reported nature dependency of the respondents by residence types. *Source:* Authors' own elaboration.

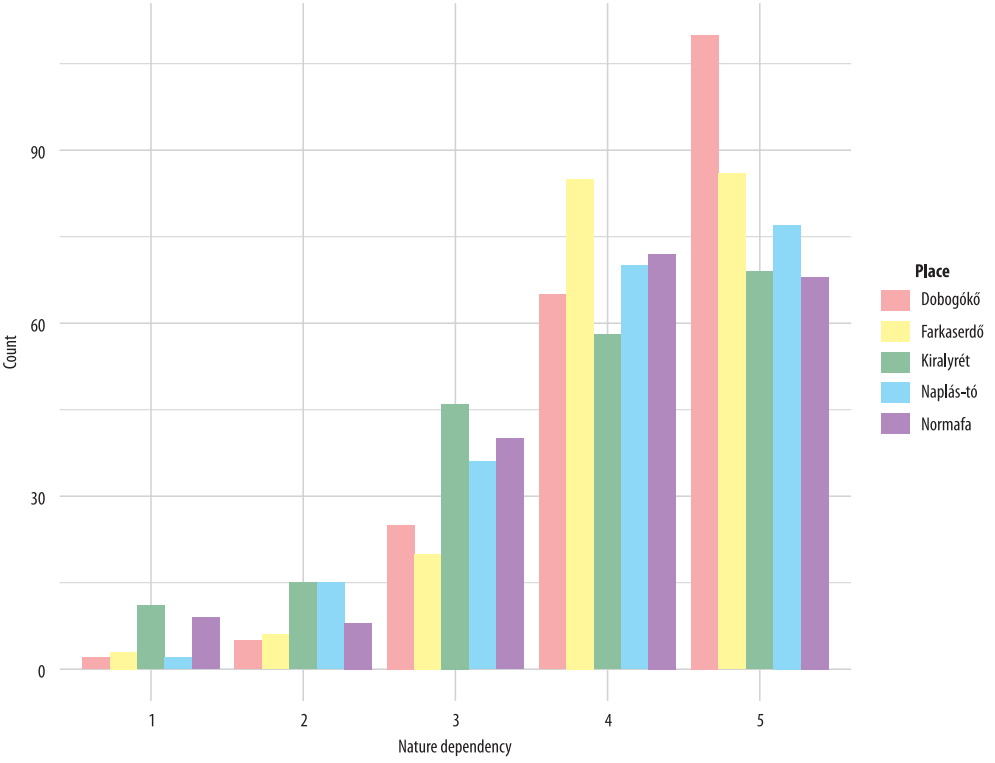

Fig. 4. Self-reported nature dependency of the respondents by the location of the survey. *Source:* Authors' own elaboration.

where questionnaires were completed also affected the value people assigned to forests. Although people chose the cheapest option at a higher rate at every location, this rate was the highest at *Királyrét*. At *Naplás-tó*, people were more willing to opt for slightly higher-priced options, followed by *Farkas-erdő* and *Normafa*. *Dobogókő* hikers most often chose the two most expensive forest value equivalents (*Figure 5*).

In the case of willingness to volunteer for forest maintenance and the questions addressing PEB, there were only slight, insignificant differences. Suburban newcomers garden the least and buy the least unpackaged goods. In volunteering, most respondents picked the choice that they would contribute to forest maintenance financially. However, if we consider the four questions on volunteering, food shopping, and gardening as a PEB index, the difference would be significant; Budapest respondents have the highest and suburban newcomers have the lowest scores (see *Appendix 1*).

Knowledge and green policy support

As mentioned in the methods section, forest-related environmental knowledge, climate change, and willingness to support green policy/orthodox energy policy were addressed with 5-point Likert-scale questions (*Figure. 6*). Knowledge about Hungarian environmental issues was good; however, it was independent of all the explanatory variables (residence type, education, forest visit frequency).

Most respondents were willing to support green policy options. The green policy

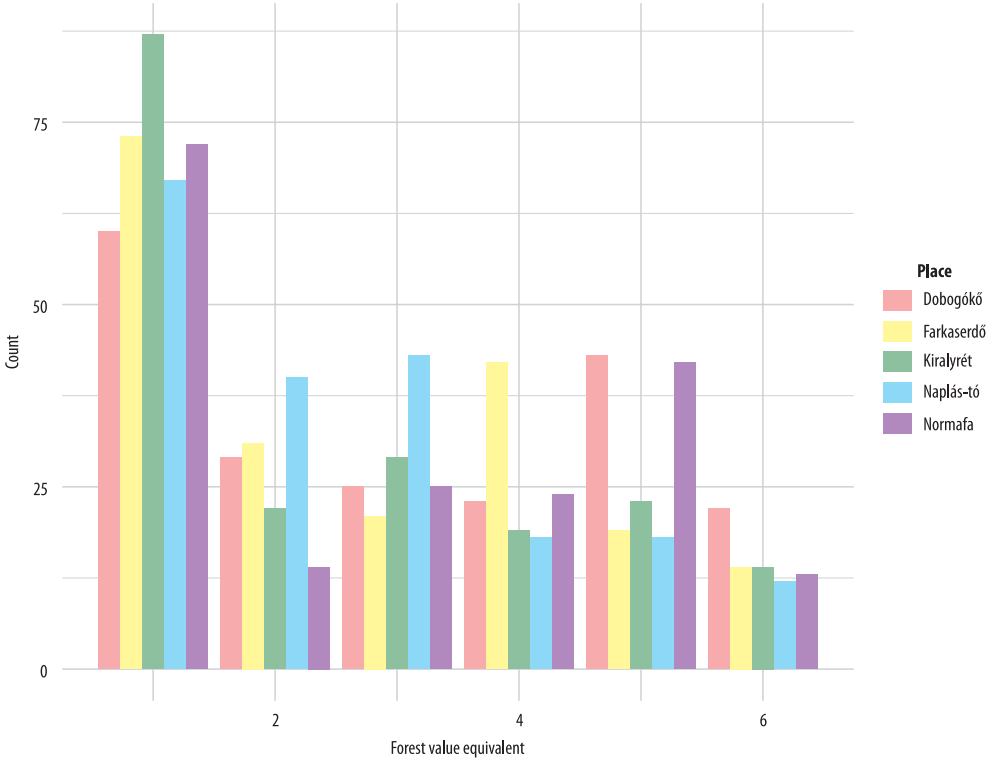

Fig. 5. Forest value equivalent scores in the light of the venue of the survey. *Source:* Authors' own elaboration.

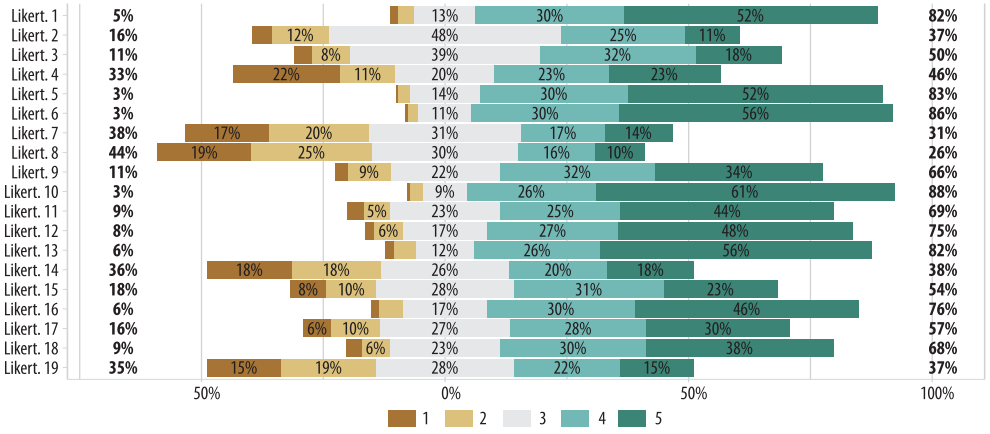

Fig. 6. Answers to the Likert-scale questions. *Source:* Authors' own elaboration.

support score index was independent of the residence type and forest visit frequency; however, education level affected it positively. People with high school graduation and higher levels of education were more likely to support green policy initiatives (e.g. green area development, enlargement of nature conservation areas, wetland rehabilitations, wind energy developments, etc.) than those with only an elementary school degree (ANOVA $F = 4.64$, $p = 0.003$; Tukey HSD: *Appendix 2*). However, the reintroduction of large predators (wolves, bears, lynx) was a highly divisive issue. But again, the location of the survey had a significant effect on green policy support (*Figure 7*), as respondents expressed stronger green policy support at *Dobogókő* and *Farkas-erdő* (ANOVA $F = 13.41$, $p < 0.001$; Tukey HSD: *Appendix 3*).

Discussion

While the respondents were in general uncertain about the environmental status of the country, countryside respondents tended to regard the environmental situation in Hungary more negatively, perhaps due to so-called environmental amnesia (Miller, J.R. 2005), i.e. urban residents have looser tights to nature and experience the visibility problem (Jankó, F. *et al.* 2018; Hafenscher, P. and Jankó, F. 2022; Vinnari, E. and Vinnari, M. 2022), which could be factors in not seeing air pollution as a problem. However, it should be noted that the rural residents surveyed do not represent the whole countryside population of Hungary. Notably, climate change is not visible from bottom-up perspectives and only received a few mentions by the respondents.

Unsurprisingly, our data showed that (sub) urban residents have fewer opportunities to visit forests. Relatedly, those who moved

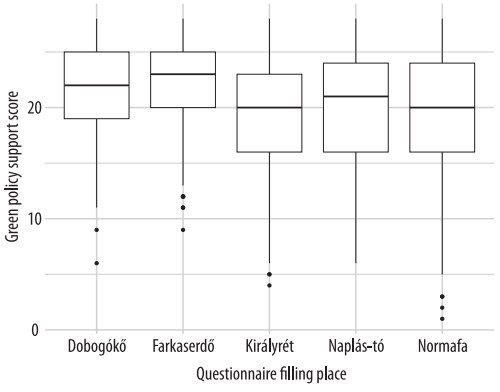

Fig. 7. Green policy support score in light of the venue of the survey. *Source:* Authors' own elaboration.

to the countryside from Budapest were not motivated explicitly by the proximity to forests but rather by other nature-related activities like gardening, which supplements the findings of the existing literature (Kok, H. and Kovács, Z. 1999; Bajmócy, P. *et al.* 2011). However, suburban newcomers have fewer opportunities to practice gardening. Time-use patterns could explain these differences.

Although the literature provides evidence that nature exposure significantly contributes to physical and mental health (Jimenez, M.P. *et al.* 2021; Schönbach, D.M.I. *et al.* 2022; Wicks, C. *et al*. 2022; Nguyen, P.-Y. *et al*. 2023), our sample only partly supports this. The respondents' subjective self-scoring could explain these discrepancies.

Nature connectedness and dependence are at the forefront of research in environmental education. Our basic results using only one 10-point Likert-scale question correspond with the main arguments that countryside respondents feel closer to nature and depend more on it (Navarro, O. *et al.* 2022). Our data also showed that financial security reduces feelings of nature dependence. Education level revealed the opposite. People with higher education levels were more sensitive to environmental concerns. The frequency of forest visits also fortified feelings of nature dependency. Those who barely visited forests had a much weaker nature dependency score. This result concords with Schönbach, D.M.I. *et al.*'s one (2022); therefore, forests play a vital role in HNC; however, other factors are also meaningful, like socio-economic factors, living conditions, and education. These findings offer an interesting area for development in communication. The more prosperous should understand that the long-term maintenance of prosperity depends on natural resources. However, the relationship between HNC and demographic factors is uncertain in the literature (Cartwright, K. and Mitten, D. 2017; Whitburn, J. *et al.* 2020; Marcias-Zambrano, L. *et al*. 2024).

The effect of the surveying locations on responses is also under investigation (Chiang, Y.-C. *et al*. 2017). Our positive results here on HNC could be explained by the fact that *Dobogókő* is a historic and transcendental place of the Hungarian hiking movement, while *Farkas-erdő* is a venue of natural beauty in contrast with the large housing estate nearby. *Normafa* and *Királyrét* are over-urbanized "forest gates" with added infrastructures. The surveying locations showed a notably similar pattern in the case of forest valuation and green policy support. However, our findings here are incomplete, and the issue should be investigated more fully in the future.

Furthermore, it is not surprising that respondents mostly chose the cheapest option in forest valuation. Also, it seems that those who spend less time in the forest tend to value the occasions more. When the valuation was modelled with the respondents' contingent volunteering action, respondents showed only a bit more willingness, hence a bit higher valuation. Concerning the pro-environmental indicators, there was only a slight difference, where Budapest residents showed higher engagement. These results are somewhat contradictory with their low nature connection; however, together with all our results, they strengthen the opinion in the reviewed literature that supports the existing urban-rural divide in environment-related attitudes. Infrastructure differences could be institutional barriers that hinder PEB (see in review: Dioba, A. *et al.* 2024), i.e. people in Budapest have more opportunities to buy packaging-free products or fruits and vegetables from farmers' markets, while gardening is more accessible in the agglomeration and rural areas.

Our results raise the question of whether background factors like education, socio-economic status, ages of residents in residence types, and migration status explain the connections between HNC and PEB. To address this question, we applied an interaction and an additive model. Although the interaction between settlement type and income level (living conditions) proved to be statistically significant (e.g. Suburb.Q: Living.conditions^5, p = 0.0289), the interaction model

resulted only in a modest improvement in explanatory power compared to the additive model (e.g. a minimal increase in R^2). This suggests that while some interaction effect may be present, the more complex model does not offer substantially better predictive accuracy. Therefore, the additive model was kept as the primary analytical framework.

The present paper faced some study limitations. First, Budapest residents comprise a more heterogeneous population compared to the other subsamples scattered across a wide spectrum according to livelihood, local environments, etc. The study could not control these in its sample. Second, our survey ignored the effects of politico-environmental ideologies on respondents' thinking about the topic; Hungarian political circumstances hardly contribute to meaningful dialogues in an explicit form. Third, our survey addressed forest visitors and not the entire population. Thus, the study is non-representative; however, the sample size made it possible to analyse some correlation in the suburban area of Budapest.

Conclusions

The present study aimed to fill a research gap concerning the role of forests in environment-related well-being and activities and better understand how residence type and related factors affect forest use, HNC, and PEB in the Hungarian capital and its suburban area. Our results showed that there are some significant connections; the urban-rural divide was most visible in the case of environmental awareness and problems, self-reported HNC, and some PEB measures; however, other cases did not offer clear explanations in this direction. What is more, our results not only underscore the importance of socio-demographic factors that could have a role in considering some issues, but the venue of the survey could also have a decisive effect in some cases; thus, this problem should be addressed with more focused research.

Beyond the explanatory factors, the perception of the Hungarian environmental situation is positive; however, the visibility-invisibility issues and ecosystem services benefits should be addressed and highlighted through environmental communication efforts. Similarly, the localization of climate change is an urgent task for environmental experts and politicians. Relatedly, urban development should use the newest, nature-based initiatives, not only for climate change adaptation, but also to engage and reconnect local people with nature, i.e. the environment. Forests are vital, especially in and around urban areas with high environmental impact and visitor expectations. Developing their public relations and mutual recognition is an urgent issue for forestry professionals and environmental educators.

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Appendix 1

Variables of the analysis

Variable types				
Grouping variables	Residence type	Venue of questionnaire survey	Demographic features	Forest visit intensity*
			Education	Q10 + Q11
			Income	
			Age	
			Gender	
Dependent variables	Nominal	Ordinal	Numeric	Likert-scale***
	Q2	Q1	Q17–20: PEB**	Environmental knowledge: L2–4, L7–8
	Q8	Q5		Green policy support: L5–6, L9–13, L16, L18
	Q9	Q6		Other
		Q7		
		Q10		

* The index was created by summing two questions. The first one was "How often do you visit forests?" (Q10). The choices were scored based on frequency: daily (score: 5); at least weekly (score: 4); at least monthly (score: 3); less often (score: 2); never (score: 1). The second was "How much time do you usually spend in the forest per occasion?" (Q11) The choices were scored based on duration: more than two hours (score: 5); 1.5–2 hours (score: 4); around 1 hour (score: 3); around half an hour (score: 2); around 15 minutes (score: 1). The new variable was created by summing the scores of the two questions.

** Pro-environmental behaviour (PEB) index was derived from ordered variables (Q17, 18, 19, 20). Answers for question 19 – "Where do you usually get your vegetables and fruits from?" – were converted to scale, depending on the level of environmental consciousness: the most conscious choice was self-grown or a relative grows the fruits and vegetables; while the less conscious choice was the supermarket. Then, the scores of questions (17) to (20) were summarized to create a new variable: *Pro-environmental behaviour score*.

*** These questions were classified in two groups: environmental knowledge regarding Hungary (L2-4, L7, L8) and willingness of green policy support (L5, L6, L9–13; L16, L18). L1, L17 and L19 measured mindset about climate change, hydroelectric power plant and development of coal and natural gas mining; L14 measured opinion about the reintroduction of large predators (wolves, bears, lynx), but whereas it is a highly controversial topic, it was omitted from further analysis (see *Figure 7*).

Appendix 2

Turkey HSD – Green policy support

Education	Difference	Lower	Upper	p-value
Secondary school, no graduation – Elementary school	1.88	-0.31	4.08	0.123
Secondary school, graduation – Elementary school	*2.49*	*0.60*	*4.36*	*0.004*
University/Collage – Elementary school	*2.60*	*0.73*	*4.48*	*0.002*
Secondary school, graduation – Secondary school, no graduation	0.60	-0.85	2.05	0.708
University/Collage – Secondary school, no graduation	0.72	-0.72	2.17	0.571
University/Collage – Secondary school, graduation	0.12	-0.76	1.00	0.985

Appendix 3

Turkey HSD – Green policy support

Place of filling the Qa	Difference	Lower	Upper	p-value
Farkas-erdő–Dobogókő	0.17	-1.17	1.52	0.997
Királyrét–Dobogókő	*-2.53*	*-3.88*	*-1.19*	*<0.001*
Naplás-tó–Dobogókő	*-1.72*	*-3.06*	*-0.38*	*0.004*
Normafa–Dobogókő	*-2.30*	*-3.65*	*-0.96*	*<0.001*
Királyrét–Farkas-erdő	*-2.71*	*-4.06*	*-1.35*	*<0.001*
Naplás-tó–Farkas-erdő	*-1.89*	*-3.25*	*-0.54*	*0.001*
Normafa–Farkas-erdő	*-2.47*	*-3.83*	*-1.12*	*<0.001*
Naplás-tó–Királyrét	0.81	-0.54	2.17	0.474
Normafa–Királyrét	0.23	-1.13	1.59	0.990
Normafa–Naplás-tó	-0.58	-1.94	0.78	0.769