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D2.3 Report of stakeholders' perceptions of risks and NbS acceptance

GREEN-INC

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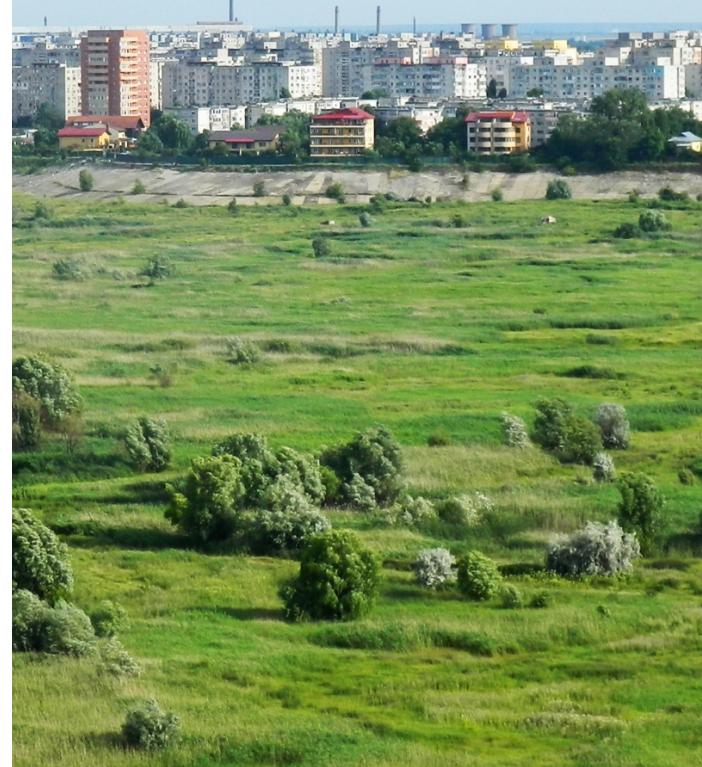
DUT Driving Urban Transitions

GREEN-INC report

D2.3 Report of stakeholders' perceptions of risks and NbS acceptance

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Picture frontpage: Văcărești Nature Park, Bucharest, Romania

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I. Introduction

This report is part of Work Package 2 (WP2) of the GREEN-INC Project (https://green-inc.eu/). WP2 aims to examine the spatial distribution of urban vulnerabilities and climate risks in three case studies (Amsterdam, Brussels and Bucharest), along with stakeholders' perceptions and values to support evidence-based decision making for more inclusive nature-based solutions (NbS). This report (D2.3) integrates Task 2.3 in which the perceptions of stakeholders of climate risks and NbS acceptance along with issues of inclusivity and individual values have been assessed in four case studies from four partner cities: Amsterdam, Brussels, Bucharest and Turin. Beyond the three cities originally outlined in the Task 2.3 description, the City of Turin was incorporated to strengthen the relevance of the analysis (Fig. 1). Given that this city is undertaking research activities involving similar forms of analysis, its inclusion facilitates comparative assessment and improves methodological comparability across the case studies.
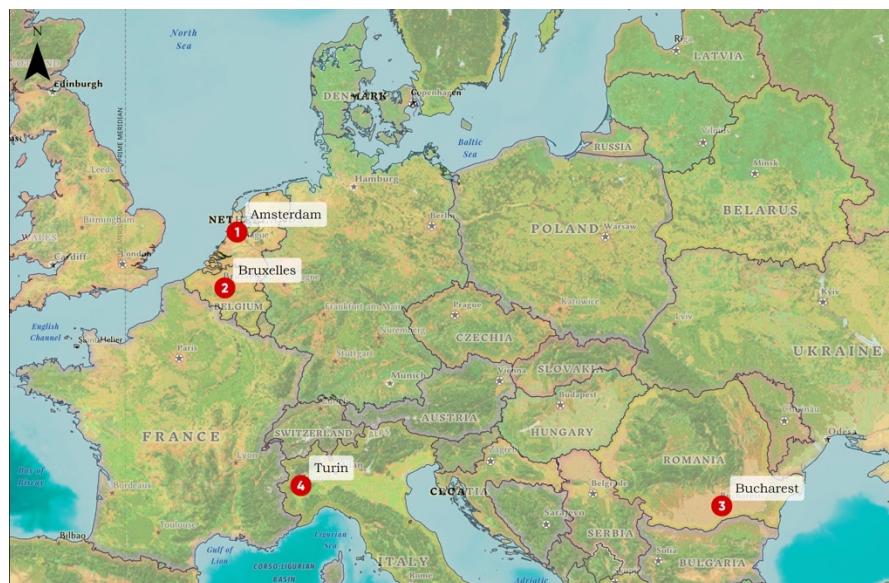
Figure 1. Case study sites for the application of the survey

II. Methodological Approach

The case studies

Bucharest is the capital of Romania and has the largest population concentration in South-East Europe with 2.12 million residents and a population density of 8840 inhabitants per km² (Petrișor et al., 2022). It covers a total area of 240 km^2. The northern part of the city is

covered by a larger share of green spaces compared to the southern parts where green spaces are more fragmented (Patroescu et al., 2009). The city has been confronted lately with intense heatwaves and drought (Cheval et al., 2025) as well as heavy storms and pluvial flooding. The city has potential for embracing nature-based solutions, however related planning and implementation processes remain at an early stage of development (Pânzaru et al., 2022).

The city of Turin is located in the northwestern Italy (being the capital of the Piemonte region). With approximately 850,000 residents and an average population density of 6500 inhabitants per km^2 the city covers an area of 130 km^2 (ISTAT, 2024). With regard to climate risks, the city has most frequently experienced heatwaves and drought, as well as episodes of pluvial flooding. To address these climate risks, multiple initiatives have implemented nature-based solutions across both local and city-wide scales (Banaei, 2024).

Amsterdam is the capital and largest city of the Netherlands, with 931,298 residents and a population density of 4,951 inhabitants per km^2 in 2024 (CBS, 2024). The city covers a total area of 219.49 km^2 (Maas, 2024). Climate change poses a significant threat to Amsterdam, as the city faces substantial risks from waterlogging, rainfall, flooding, and heatwaves. Thus, the planning of nature-based solutions for climate resilience and adaptation is based on policies and strategies that identify health, local needs, social well-being, and other priorities (Mabon et al., 2022).

Brussels is the capital of Belgium, located in north-central Belgium. In 2024, with approximately 1.2 million residents and a population density of 7,694 inhabitants per km^2, covering a total area of 162 km² (BISA, 2025). Brussels is among the cities particularly vulnerable to pluvial flooding, as well as flooding from watercourses overflowing (Essenfelder et al., 2022; Khodadad et al., 2025). To address these water challenges, a key planning policy focuses on developing a network of interconnected green areas (Khodadad et al., 2025).

The questionnaire and data collection

A standardized questionnaire has been set up in an online survey software and administered from May to December 2025 in the local languages of each case study (Bucharest in Romanian language, Amsterdam in Dutch language, Brussels in French language and Turin in Italian language), including in English given the international character of the selected European cities and to facilitate the participation of a broader spectrum of stakeholders. The questionnaire was approved through the University of Bucharest ethical approval process (164/08.04.2024). It was targeted to reach different stakeholder groups: those having a professional as well as a non-professional involvement with climate change and nature-based solutions (NbS). The link to the questionnaire has been sent as an email invitation to contacts from quadruple helix representatives: public institutions (e.g., municipalities, environmental institutions), public and private companies (e.g., real-estate developers, retailers), academia (e.g., universities, research institutes), and civil society (e.g., community groups, NGOs), as well as authors' professional and personal contacts. A snowball sampling approach has been used to engage with more stakeholders in each city.

The questionnaire included the following sections (see Appendix I):

(i) **The socio-demographic profile.** This section collected information about the professional or non-professional involvement of the respondents with climate change and NbS; Age and Gender (*Questions 1, 2 and 3*).

(ii) **Societal challenges and exposure to climate risks.** The societal challenges and exposure to climate risks on different levels of intensity, along with their negative impacts have been assessed (*Questions 4, 5 and 6*). Perceptions on societal challenges were based on Ferreira et al., (2021) while on exposure to climate risks were based on Enu et al., (2024).

(iii) **Preference for and acceptance of nature-based solutions** and their impacts on climate risks and communities were considered (*Questions 7, 8, 9 and 10*). For question 7 a set of pictures was used to illustrate different NbS measures based on Enu et al., (2024). The respondents assessed the relevance of each NbS measure to three relevant climate risks: *heat*, *flood risk* and *drought*.

(iv) **Aspects of inclusivity and social equity**. This section consists of three questions about the consideration of the public voice and the needs of vulnerable groups (*Questions 11, 12 and 13*).

(v) **Environmental values** in relation to nature-based solutions. A set of statements indicating biospheric, altruistic, egoistic, hedonic and NbS were proposed (*Question 14*). The statements were measured on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree.

Descriptive statistics were conducted to show the main findings in this current report. Non-parametric statistical tests to test differences among professional and non-professional groups, an exploratory factor analysis (EFA) (Bandalos and Finney, 2018) and generalized linear regression models will be used to test different hypotheses which will be included in a scientific article planned to be developed in 2026 (Month25-30).

A total of **489 valid questionnaires** (191 in Bucharest, 60 in Amsterdam, 104 in Brussels, 99 in Turin and 35 from other European cities (the questionnaire was reached by respondents living in European cities outside the four designated case study areas)) were retained for data analysis by the end of October 2025 and the subsequent results were included in the current report. The questionnaire was distributed by the end of December 2025 to obtain more responses and achieve comparability between the four case studies.

III.   RESULTS

The socio-demographic profile (*Question 1*). Regarding the participants' professional or non-professional involvement with climate change and nature-based solutions in Bucharest the group working professionally in the field prevails (34%), followed by the group with some professional or academic background related to these topics (24%) and the group that is not professionally involved, but interested or active (24%). The latter group, non-professionals, prevails in Amsterdam (50%), Brussels (39%) and Turin (35%) and continues to predominate when the analysis is extended to the full dataset concerning all the European cities (33%).

The demographic profile of the participants (*Questions 2 and 3*). All four case studies are uniform in terms of respondents' age and gender. Across three case studies (Bucharest, Amsterdam and Turin) participants that were **females** (61%, 60% and 55%) and aged between **19-35 years old** (55%, 55% and 47%) constituted the most frequent demographic groups. In case of Brussels, the predominant age group is 36-50 years (37%), with slightly over half being female (55%).

When looking at the two categories of respondents based on professional involvement, with regard to respondents expressing a **professional interest** with climate change and NbS the majority are females (Bucharest 63%, Turin 51%, Amsterdam 48%) and typically aged between 19 and 35 years (Bucharest 55%, Turin 74%, Amsterdam 83%) across three of the case studies. In contrast, in Brussels, most respondents with a professional interest fall within the 36-50 age group (48%) and are predominantly male respondents (56%). Regarding the group with **no professional involvement** with climate change and NbS, there is a variation across age categories: in Bucharest and Amsterdam the predominant age group is 19-35 years (55%, 39% respectively), in Turin over 65 years old (31%) and in Brussels 51-65 years (38%). Most of the non-professional respondents are females across all four case studies.

Societal challenges and exposure to climate risks. Respondents have been asked to select from a list of 18 societal challenges that they consider applicable to their city (*Question 4*). The analysis of the four case studies indicates that the most recognized societal challenges faced by the cities are: *air pollution*, *heavy traffic* and *heatwaves* in Bucharest, Brussels and Turin (Fig. 2 - 4), as well as *intense rainfall and floods* in Amsterdam (Fig. 5).
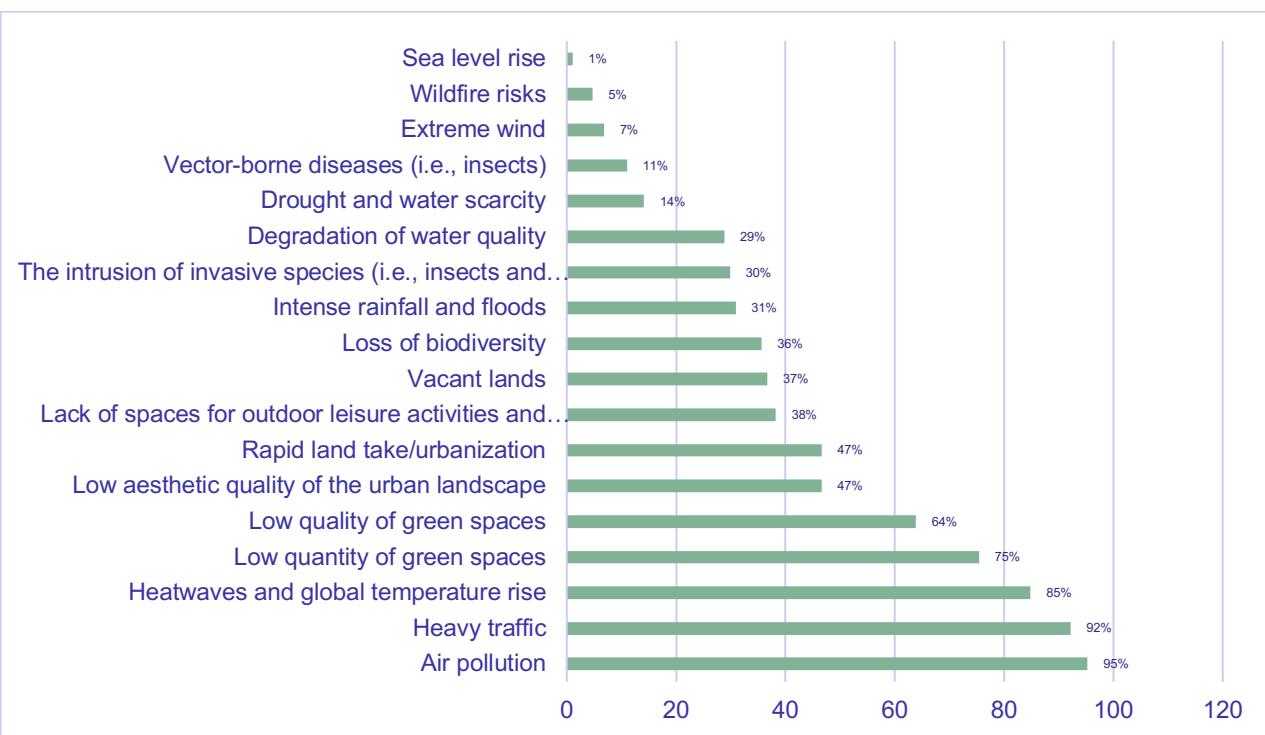
Figure 2. Societal challenges faced by Bucharest
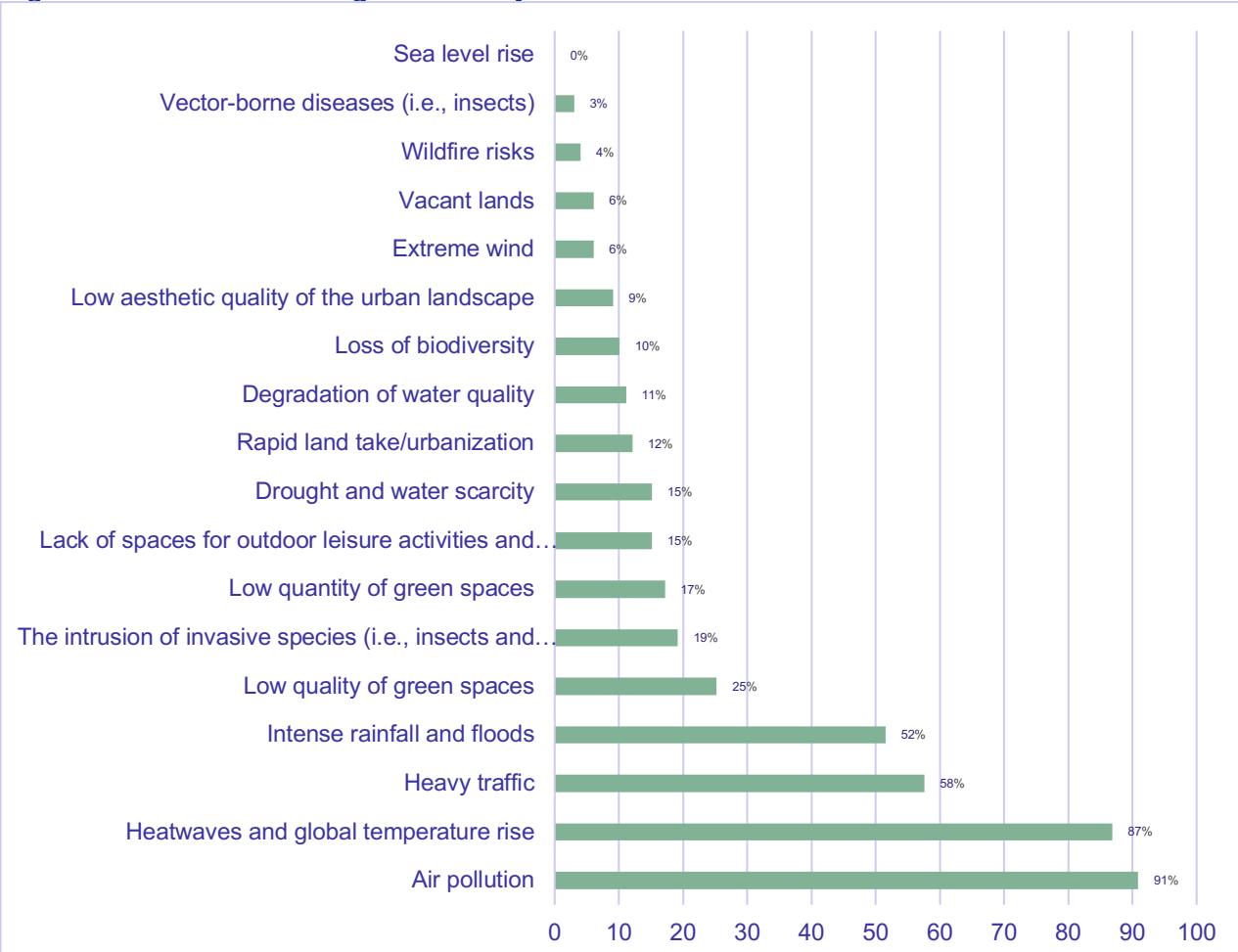
Figure 3. Societal challenges faced by Turin
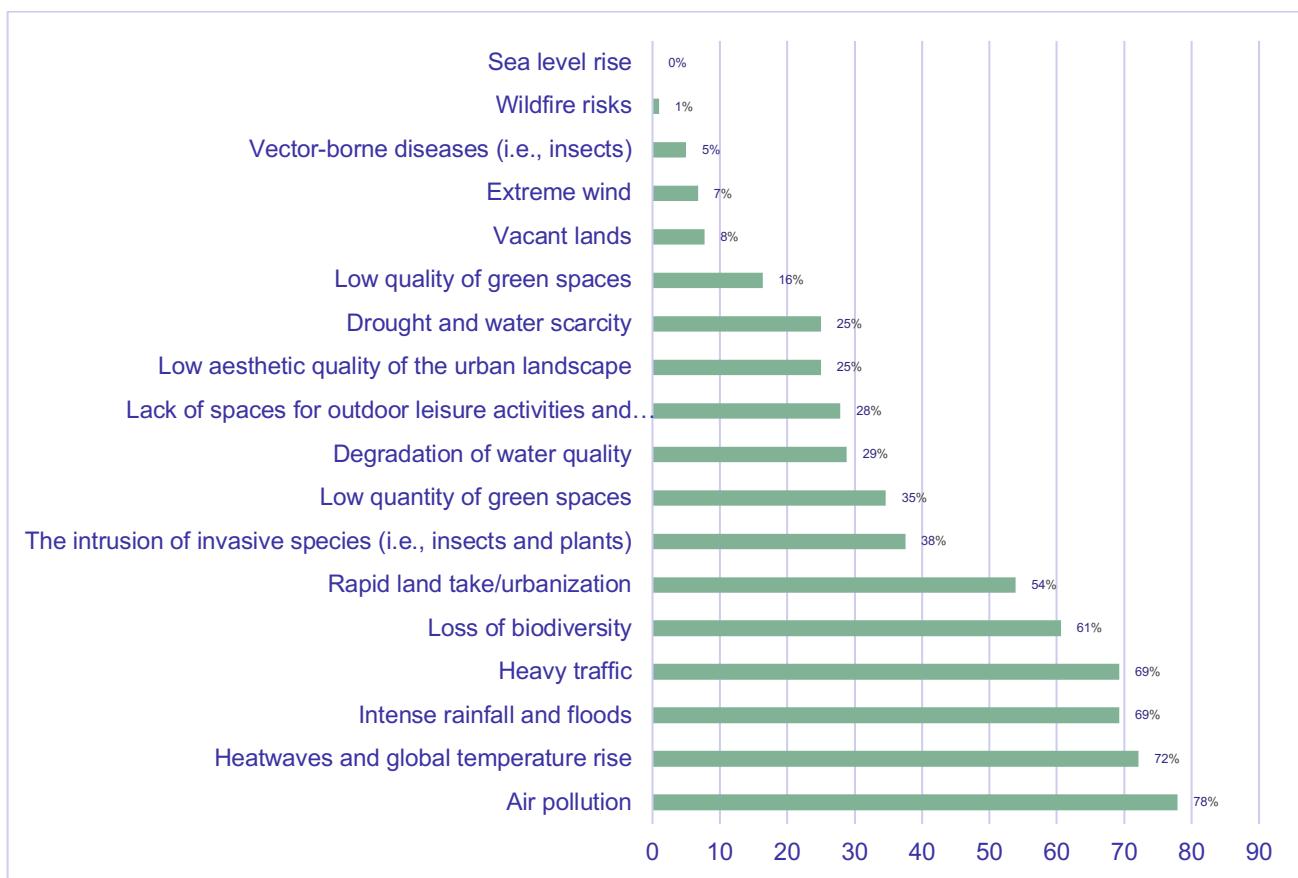
Figure 4. Societal challenges faced by Brussels
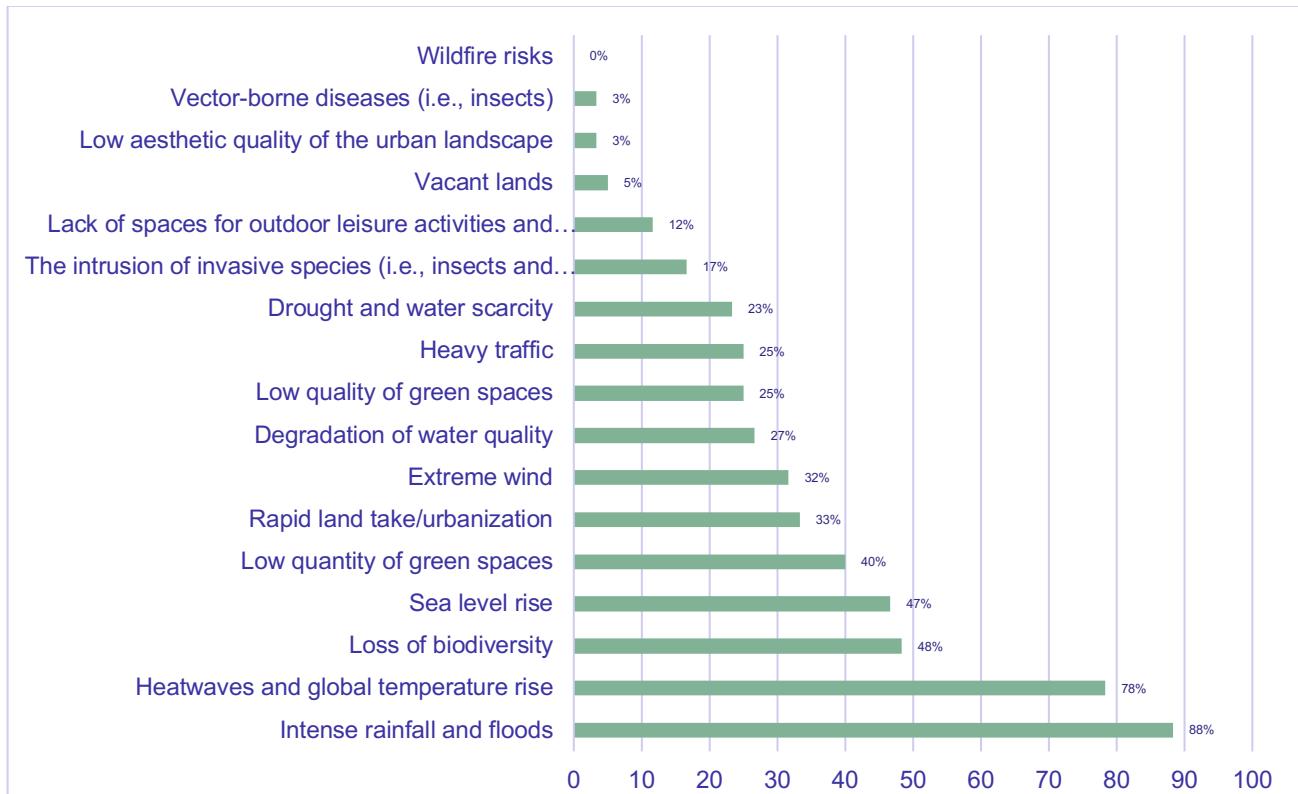
Figure 5. Societal challenges faced by Amsterdam

When looking at the exposure to climate risks on different levels of intensity (*Question 5*, measured on a five-point Likert scale ranging from (1) not intensive to (5) very intensive), the most intense climate risks in the case studies were *heatwaves* in Bucharest (Mean(M)=4.61, SD=0.69) and Turin (M=4.14, SD=0.92), *local temperature rise* in all four case studies (Bucharest M=4.54, SD=0.69, Turin M=4.30, SD=0.73, Amsterdam M=3.92, SD=0.75 and Brussels M=3.52, SD=1.40) and *intense rainfall* in Amsterdam (M= 4.24, SD=0.68) and Brussels (M=3.48, SD=1.35). This reported experience with intensive heat may be influenced by different factors, such as age group, past experiences, scarcity of green areas, neighborhood configuration (Enu et al., 2024). Some of them will be investigated in the extensive scientific paper planned to be developed (Month 25-M36).

These climate risks along with their levels of intensity are perceived differently by respondents with professional vs. non-professional interest in climate change and NbS (Table 1). In general, non-professionals attribute lower levels of intensity to climate risks that are perceived by professionals as highly intense. Conversely, the climate risks that professionals are considering of low levels of intensity (e.g., wildfires) are rated slightly higher by the non-professionals.

Table 1. Perceived levels of intensity for climate risks (average for a five-point Likert scale ranging from (1) not intensive to (5) very intensive)

	Professional				Non-Professional			
	Bucharest	Turin	Amsterdam	Brussels	Bucharest	Turin	Amsterdam	Brussels
Heatwaves	4.71	4.36	3.65	3.45	4.52 ↓	3.94 ↓	3.75 ↑	3.30 ↓
Local temperature rise	4.61	4.48	3.78	3.70	4.49 ↓	4.14 ↓	3.97 ↑	3.32 ↓
Heavy storms	3.54	4.02	3.45	2.65	3.41 ↓	3.72 ↓	3.67 ↑	2.49 ↓
Drought & water scarcity	3.19	3.16	2.90	2.98	3.47 ↑	2.71 ↓	3.47 ↑	2.70 ↓
Intense rainfall	3.45	3.72	4.33	3.71	3.51 ↑	3.73 ↑	4.17 ↓	3.24 ↓
Pluvial flooding	3.59	3.43	3.45	3.55	3.41 ↓	3.34 ↓	3.67 ↑	3.12 ↓
Fluvial flooding	2.08	3.54	2.76	2.17	2.22 ↑	3.63 ↑	2.45 ↓	2.23 ↑
Sea level rise	1.55	1.50	3.76	1.60	1.98 ↑	1.18 ↓	3.51 ↓	1.72 ↑
Wildfire risk	2.27	2.05	1.63	1.69	2.58 ↑	2.44 ↑	1.62 ↓	1.87 ↑

↓Orange arrow pointing down – lower rates by non-professionals in each city; ↑Green arrow pointing up – higher rates by non-professionals in each city

When asked about the experiences of **any negative impacts related to the climate risks** (*Question 6*), common examples across all four case studies included *respiratory problems, stress, anxiety, poor sleep quality, fatigue, thermal discomfort, impact on quality of life, limitations of outdoor activities, flooding, or property damage*. There were also isolated examples that were mentioned in only one of the case studies. For example, in the case of **Brussels**, the reported negative impacts included water shortage, ecosystemic impacts, overheating, desire to leave the city, and heat coping difficulty. In the case of **Turin**, the reported negative impacts included heat domes, fires, loss of human lives, and withered nature, while in the case of **Amsterdam**, they comprised agitation, mental health, heat rash, and sunburn. Finally, in the case of **Bucharest,** respondents reported various negative impacts, including irritability, headaches, exhaustion, sensitivity, overstimulation, feeling unwell, emotional impact, lack of energy, claustrophobia, insect-related issues, dehydration,

hyperhidrosis, undrinkable tap water, longer commuting time, excessive heat, and viral infections (Fig. 6).
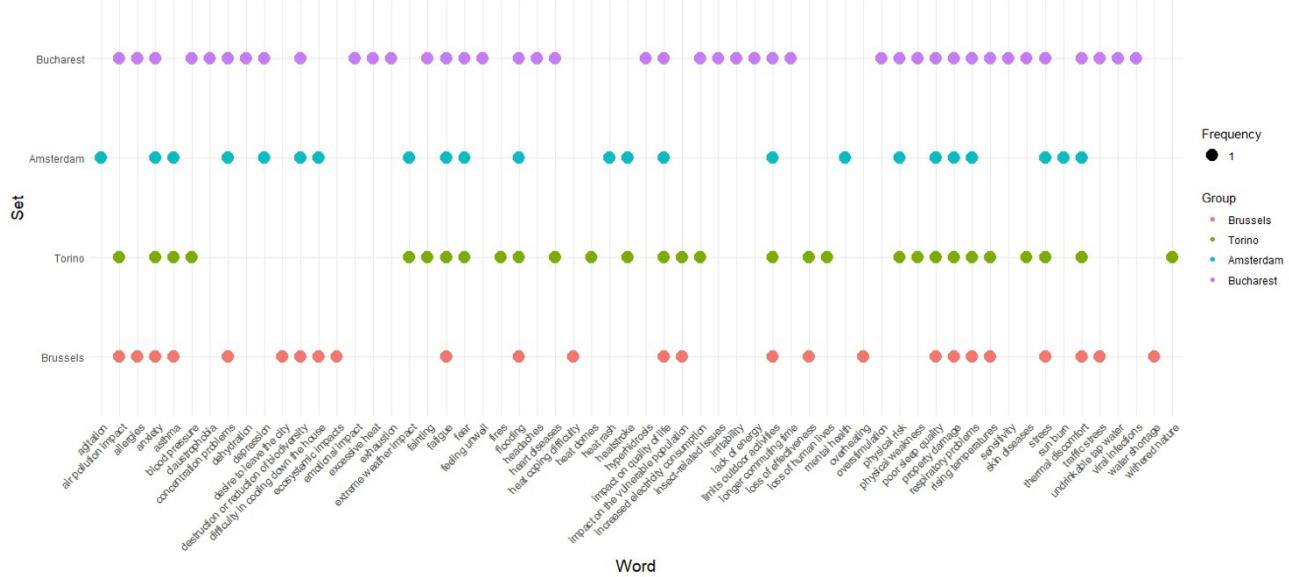
Figure 6. Negative impacts related to climate risks experienced by respondents across all four case studies

Preference for and acceptance of nature-based solutions and their impacts on climate risks and communities.

First, participants have been asked to associate a list of 16 NbS measures represented by pictures with three climate risks that these could address (*heat, flood risk and drought*) (*Question 7*).

In all four cities, the most frequently mentioned NbS that could mitigate **heat** are: *street trees*, *urban forests*, *tree planting* and *green roofs and green walls* (mentioned by more than 70% of the respondents) (Fig. 7).
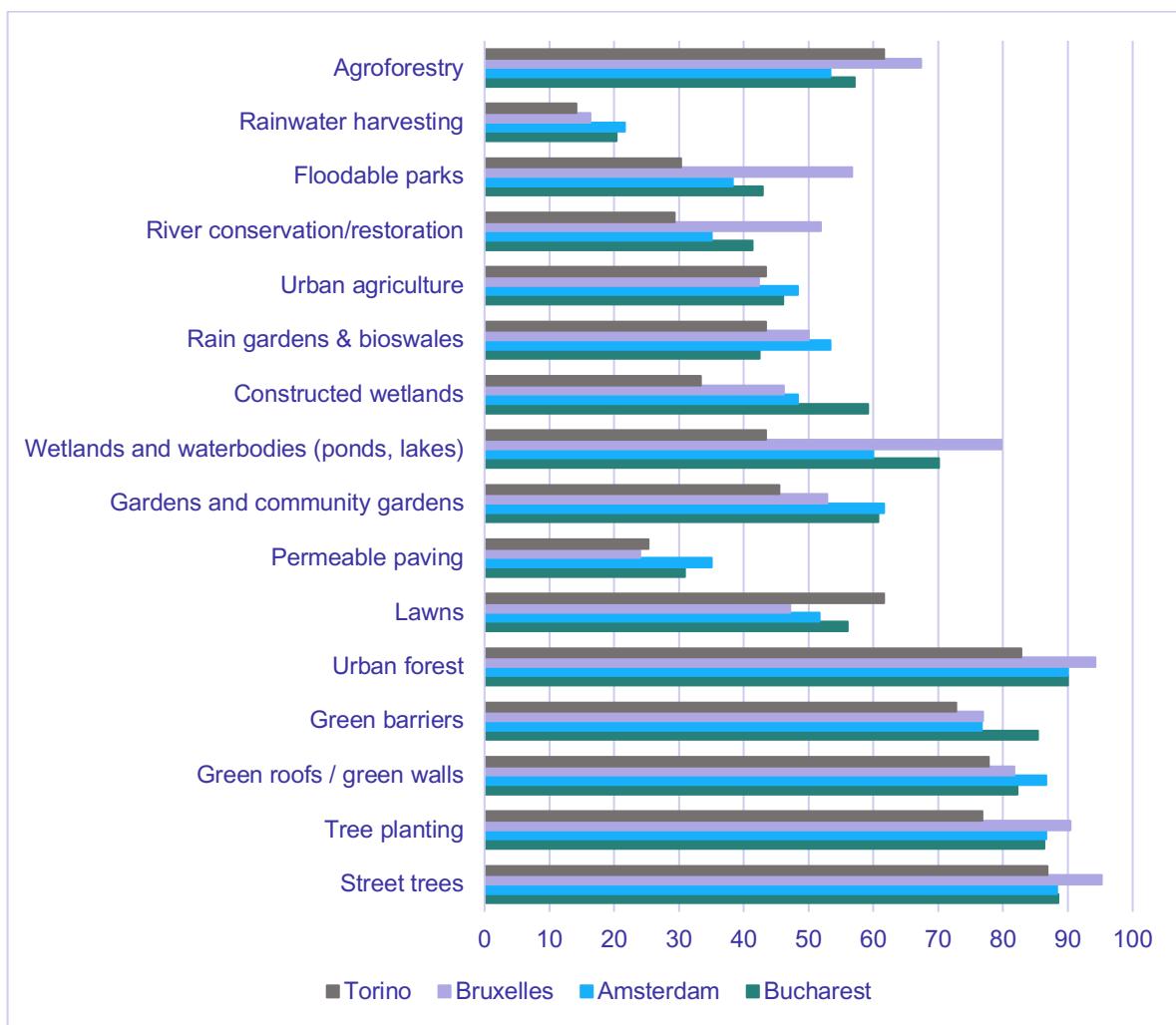
Figure 7. NbS measures to mitigate *heat* in the analyzed cities

Regarding differences between the **professional and non-professional groups**, the same heat-related NbS measures were most frequently selected by both groups. However, in Bucharest and Brussels, the **professionals** exhibited higher selection frequencies for most NbS measures (for 88% of the NbS in Bucharest and for 69% of the NbS in Brussels). In Turin, the professionals demonstrated higher frequencies for half of the NbS measures and non-professionals for another half (NbS measures such as: street trees, green roofs/barriers, tree planting, rainwater harvesting, floodable parks were more frequently selected compared to NbS measures such as wetlands, gardens, urban agriculture, river conservation. In Amsterdam, the **non-professionals** exhibited higher selection frequencies for all 16 heat-related NbS measures.

In terms of appropriate NbS to mitigate **flood risk**, the most frequently mentioned were *floodable parks*, *river conservation/restauration* and *permeable pavin*g (Fig. 8).
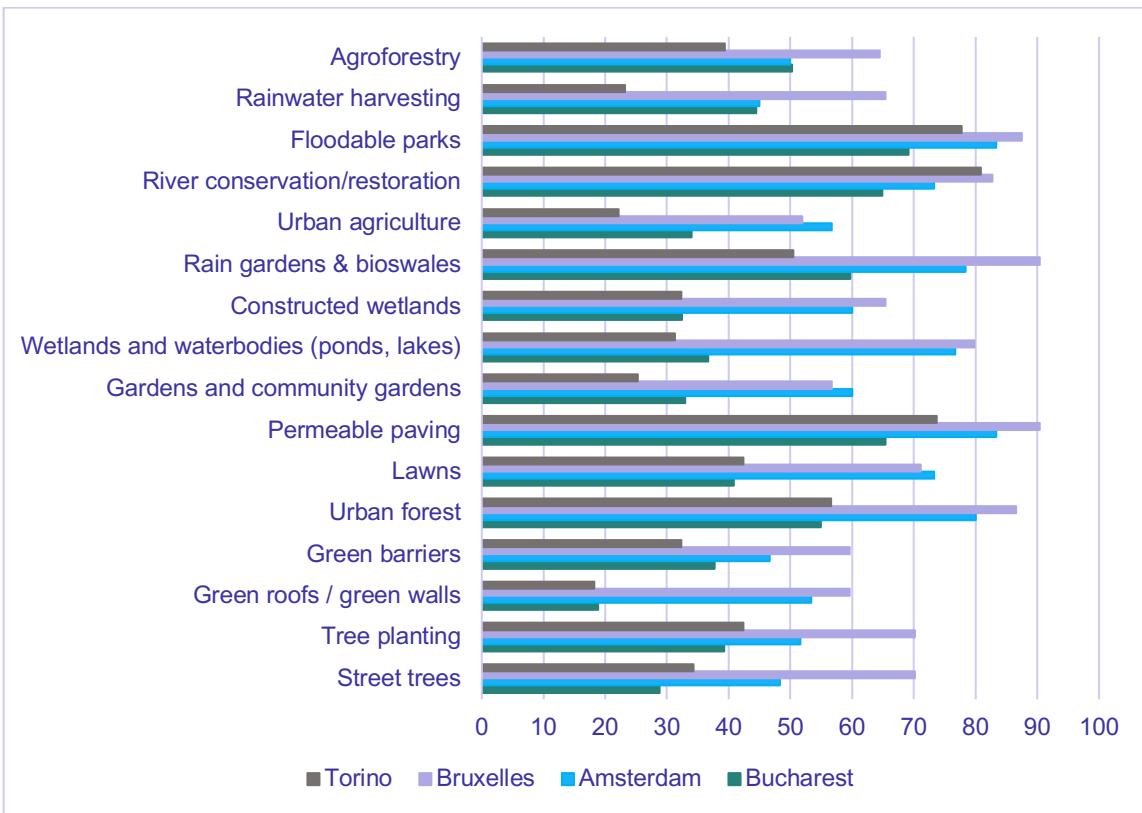
Figure 8. NbS measures to mitigate *flood risk* in the analyzed cities

Regarding the differences between the **professional and non-professional groups** when selecting NbS measures for **flood risk**, in Bucharest, Turin and Brussels, the **professionals** exhibited higher selection frequencies for most of NbS measures (for 88% of the NbS in Bucharest, for 94% of the NbS in Turin and for 69% of the NbS in Brussels). In Amsterdam, the **non-professionals** reported higher selection frequencies for half of the listed NbS measures, such as street trees, tree planting, green barrier, permeable paving, gardens and community gardens, constructed wetlands, urban agriculture and agroforestry.

Regarding **drought**, participants perceived that it could be mitigated by NbS measures such as *rainwater harvesting*, wetlands and waterbodies and *constructed wetlands* (Fig 9).

Regarding the differences between the **professional and non-professional groups** when selecting NbS measures for **drought,** in Bucharest the **professionals** tended to select higher selection frequencies for most of the NbS (for 88% of the NbS) while in Turin, Amsterdam and Brussels the **non-professionals** demonstrated higher selection frequencies for more than half of the listed NbS measures (for 69% of the NbS in Turin and Brussels, 63% Amsterdam).
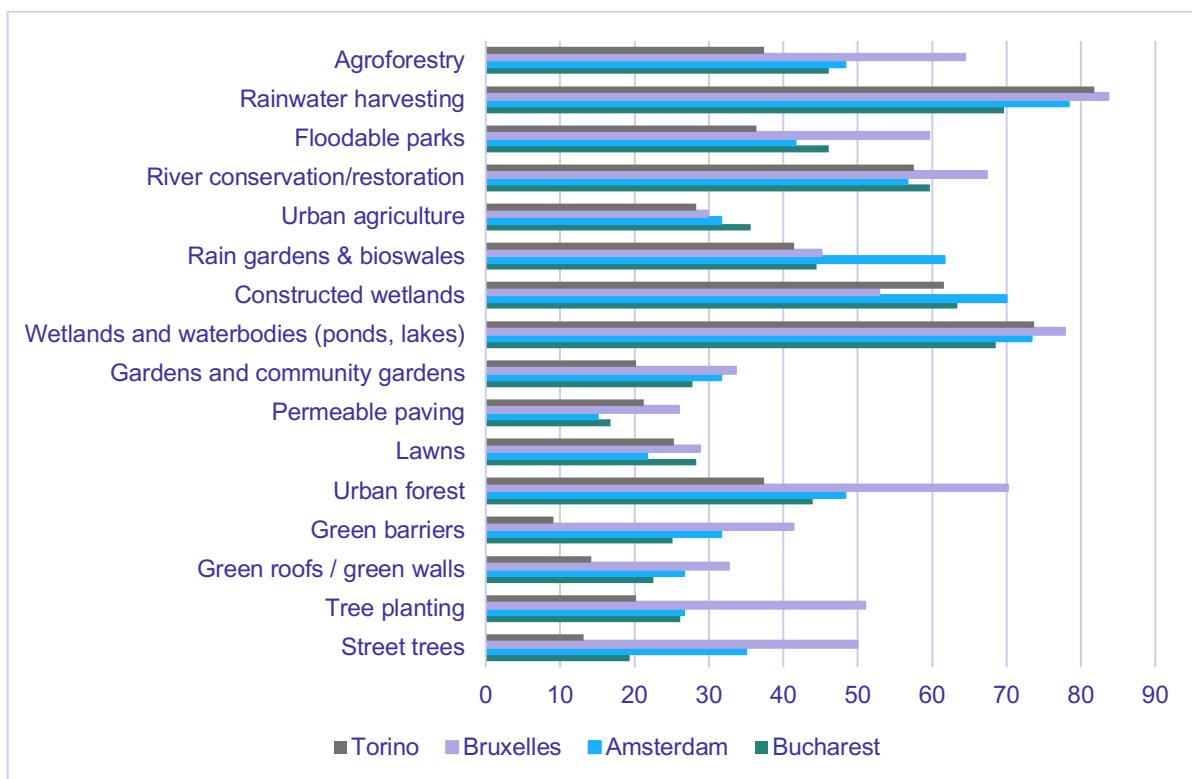
Figure 9. NbS measures to mitigate *drought* in the analyzed cities

Second, when participants have been asked which interventions (those using nature or those using constructed structures) are being prioritized to mitigate climate risks in their cities (*Question 8*), for Amsterdam and Brussels most of them (73% and 84% respectively) highlighted the NbS. In Bucharest and Turin, a lower share of respondents (32%, and 41% respectively) report that NbS are prioritized to mitigate climate risks. In Bucharest, there was the higher proportion of respondents (33%) who mentioned that NbS are not prioritized, compared to the share of respondents in the other cities (12% in Turin, 6% in Amsterdam and 6% in Brussels) (Fig. 10).
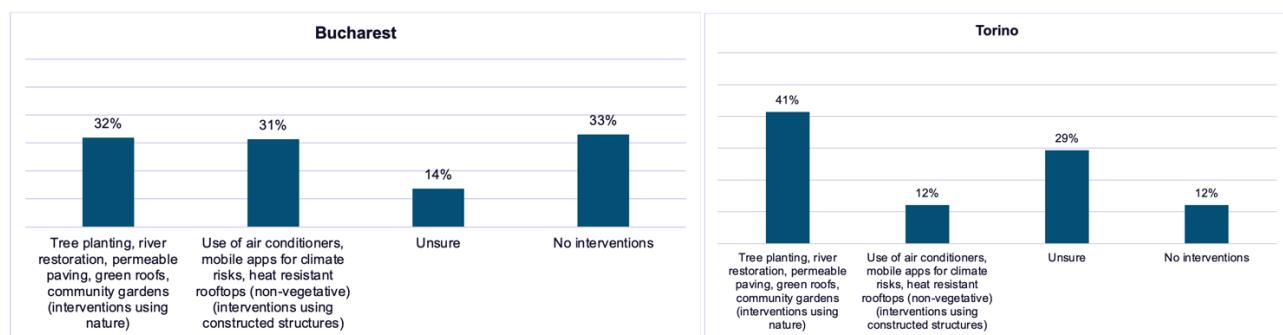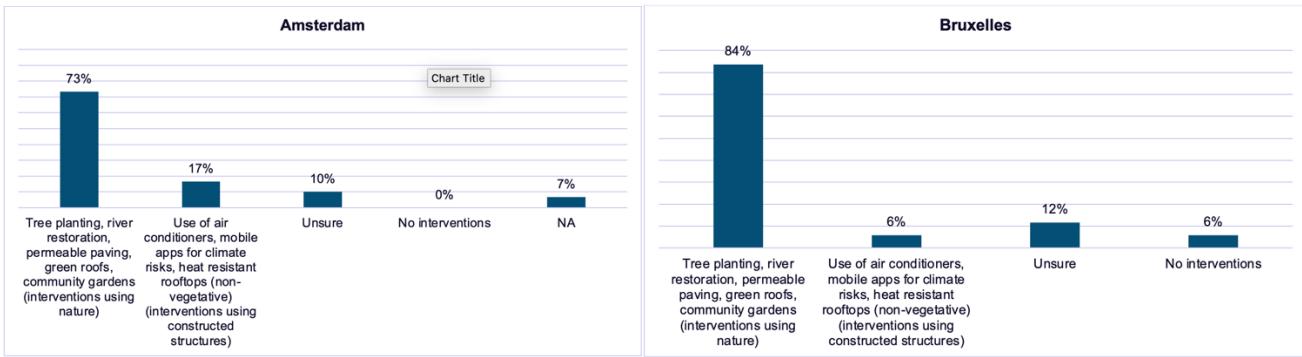
Figure 10. Prioritized interventions to address climate risks in the analyzed cities

Regarding the differences between professional and non-professional groups, the professional group in all four cities reported NbS as interventions being prioritized to mitigate climate risks (38% in Bucharest, 55% in Turin, 78% in Amsterdam and 83% in Brussels). This highlights that NbS are preferred by professionals over more traditional grey, engineering solutions. The non-professional groups reported that mostly no interventions were prioritized (31% in Bucharest) or that they felt unsure (38% in Turin). Conversely, in Amsterdam and Brussels, the non-professional group reported the use of NbS as interventions being prioritized to mitigate climate risks (69% in Amsterdam and 84% in Brussels).

Third, when asked if there are **enough nature-based interventions** (e.g., tree planting, green roofs, green corridors, gardens, etc.) in their residential neighborhood (*Question 9*), in all four case studies significant shares of respondents reported that they *disagree* (27% of respondents in Bucharest and Turin), *strongly disagree* (27% of respondents in Brussels) or are *undecided* (a high share of respondents in Amsterdam 43%) (Fig. 11).
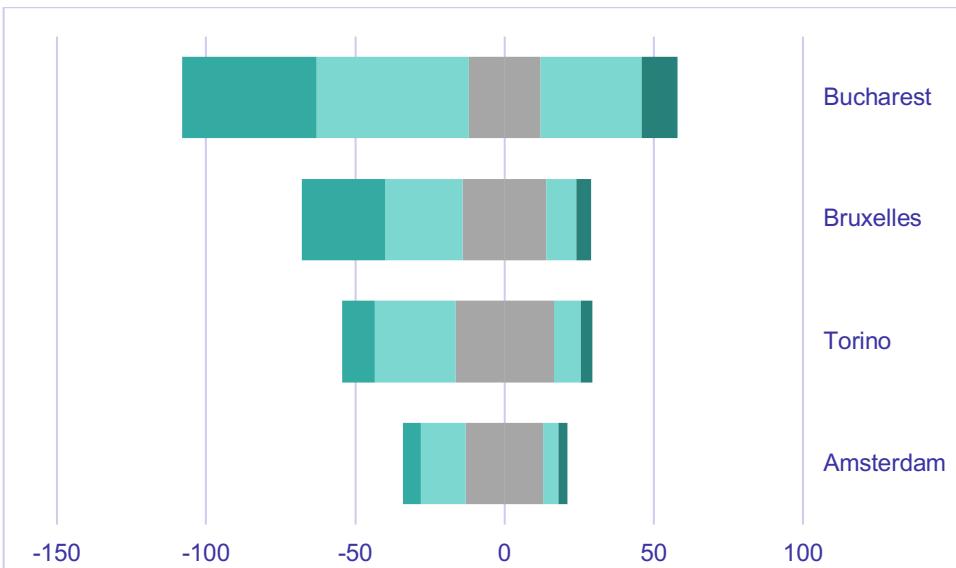

Figure 11. Perceptions whether existing NbS are sufficient in the residential neighborhoods of the respondents (*agree and strongly agree* (right pale and dark turquoises); *undecided* (middle grey area); *disagree and strongly disagree* (left pale and dark turquoises)).

Forth, when asked if the **NbS influenced how people interact in their residential neighborhood** (*Question 10*), in Bucharest 37% of the respondents reported that this is not applicable to their city, and 28% indicated that there is such an influence (Fig. 12). Moreover, 23% of the respondents reported that NbS influence how people interact, and mentioned a higher level of *socialization and interaction, going out with friends and recreational activities*. Similar results have been observed in Turin, where 33% of the respondents indicated that such a social influence of NbS is not applicable to their city, while 28% reported an influence and 26% mentioned examples of interactions such as *meetings with friends and neighbors or outdoor social activities*. Regarding Amsterdam, the results show that 37% of the respondents consider that NbS influence how people interact and another 37% of the respondents report an influence, giving examples such as *collaboration for caring the green spaces or social activities in green spaces*. Regarding Brussels, 38% of the respondents indicated an enhanced interaction due to NbS, taking shape through more *meetings with friends in green spaces or social activities with the neighbors*, while 34% reported that NbS influence on social interaction is not applicable to their city.
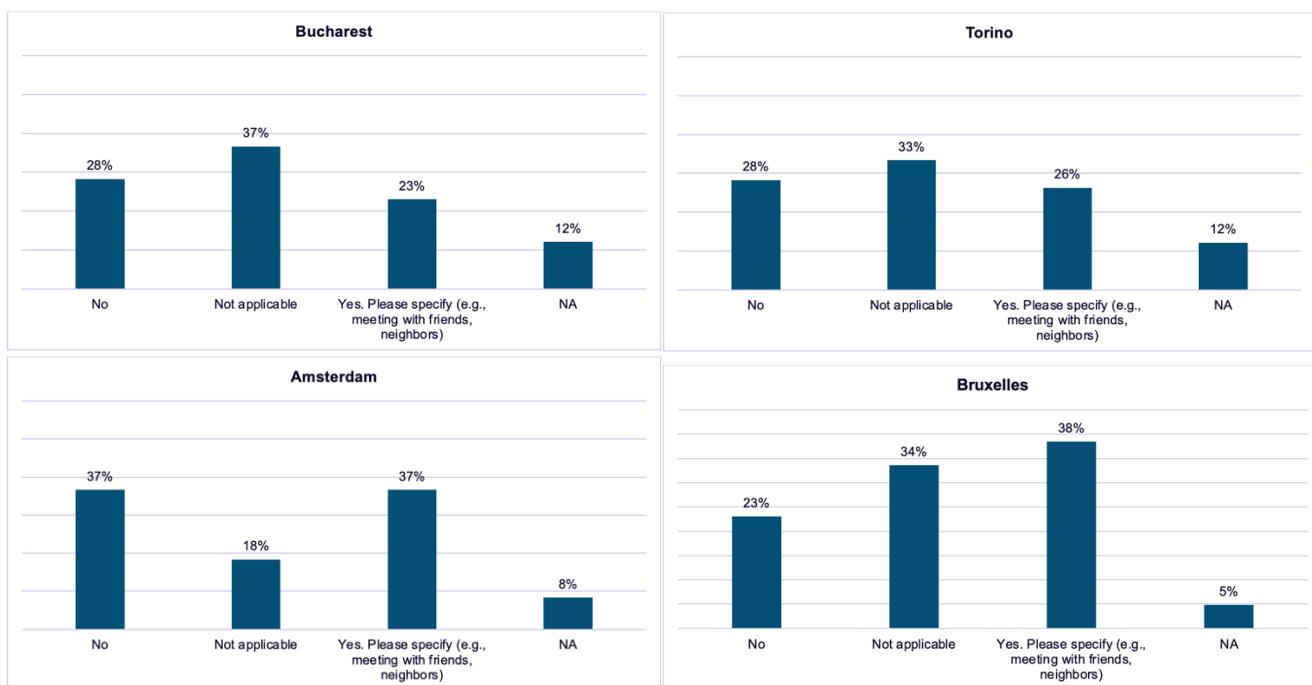
Figure 12. NbS influence on social interaction in the analyzed cities

Aspects of inclusivity and social equity. When asked if the respondents **took part in the local discussions** or contributed to city plans to make areas greener or more climate-adaptive (*Question 11*), several differences emerged in the studies cities (Fig. 13). In Bucharest only 17% of the respondents report that they participated or contributed to such initiatives, the rest of 73% indicating their absence in such activities. Similarly in Turin 71% of the respondents report that they have not been invited to participate or contributed to such initiatives. In Amsterdam a higher level of participation has been reported in the local discussions or contributions to city plans. Here 48% of the respondents indicated that they

have been invited to participate while for 43% of the respondents there was no involvement. A balanced share of respondents has also been reported for Brussels, where 43% of the respondents indicated their presence while 51% indicated their absence in such initiatives.
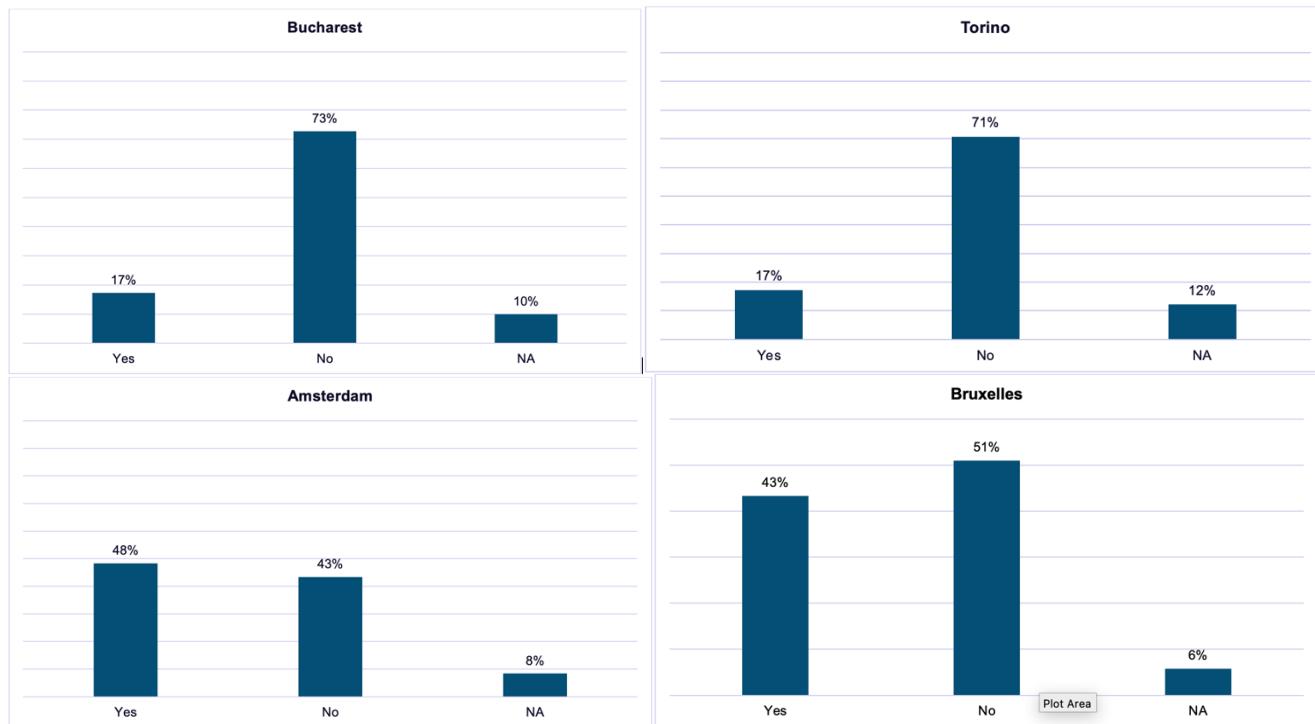
Figure 13. Presence vs. absence of respondents in the local discussions or contributions to city plans

Regarding the differences between professional and non-professional group, in Bucharest and Turin a good share of professionals reported that they have not been asked to participate in the local discussions (in Bucharest 67%, while in Turin 62%). Conversely in Amsterdam and Brussels the share of professions who have or have not been asked is more balanced (in Amsterdam 43% have been asked, 43% have not been asked; in Brussels 44% have been asked, 50% have not been asked). Regarding the non-professional group, a high share of respondents has not been asked to participate in Bucharest (81%) and Turin (80%) while in Amsterdam and Brussels, the share of non-professionals being or not being asked is more balanced (53% have been asked, 42 have not been asked in Amsterdam and 42% have been asked, 52% have not been asked in Brussels).

Respondents were further asked whether they the feel their voice is considered (*Question 12*). In all four case studies there was a low share of respondents who considered that their voice considered in local plans (Bucharest - 5%, Turin - 5%, Amsterdam - 12% and Brussels - 17%) (Fig. 14). In Bucharest a good share of respondents (40%) consider that their voice is not considered in the local plans, followed by those who are unsure (32%). In the other three case studies the respondents who were unsure represented the predominant group (35% in

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Turin, 55% in Amsterdam and 42% in Brussels), followed by the group who considered their voice was not considered (23% in Turin, 12% in Amsterdam and 27% in Brussels).
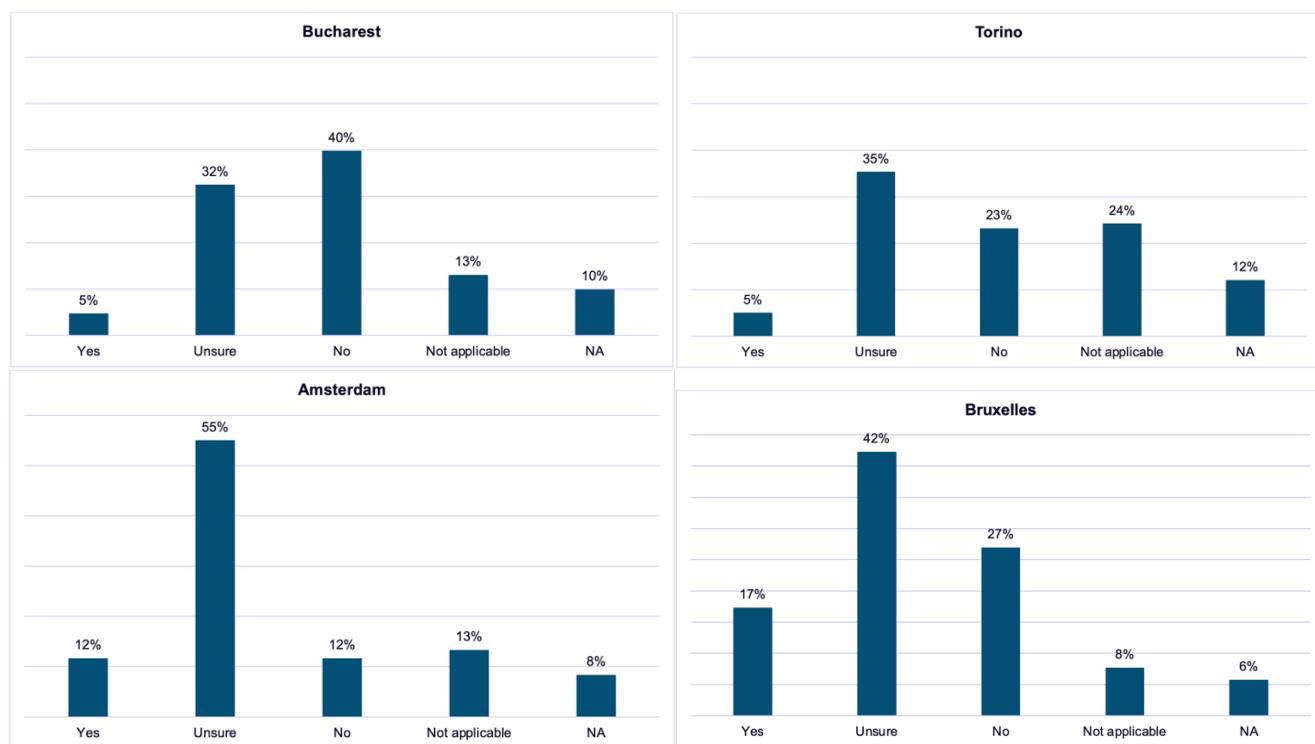
Figure 14. Perceptions of the degree to which public's voice is considered in local plans

When asked about the extent to which the **needs of people with vulnerabilities** (e.g., people with disability, having a migrant background, or being older) are considered when addressing challenges around climate change (*Question 13*), in Bucharest the respondents that disagree (30%) and totally disagree (26%) with this statement were the most predominant (Fig. 15). In Turin, several respondents were undecided (26%) or disagree (25%) that the needs of people with vulnerabilities are considered when addressing climate change challenges. In Amsterdam, 33% of the respondents did not know how to respond, 22% disagreed and 20% were undecided about the answer. In Brussels, 30% of the respondents report that they disagree about the fact that the needs of the vulnerable people are considered while 26% are undecided regarding the answer. The share of respondents who totally agree that the needs of people with vulnerabilities are considered when addressing challenges around climate change is very low (2% in Bucharest and Amsterdam, and 3% in Brussels).
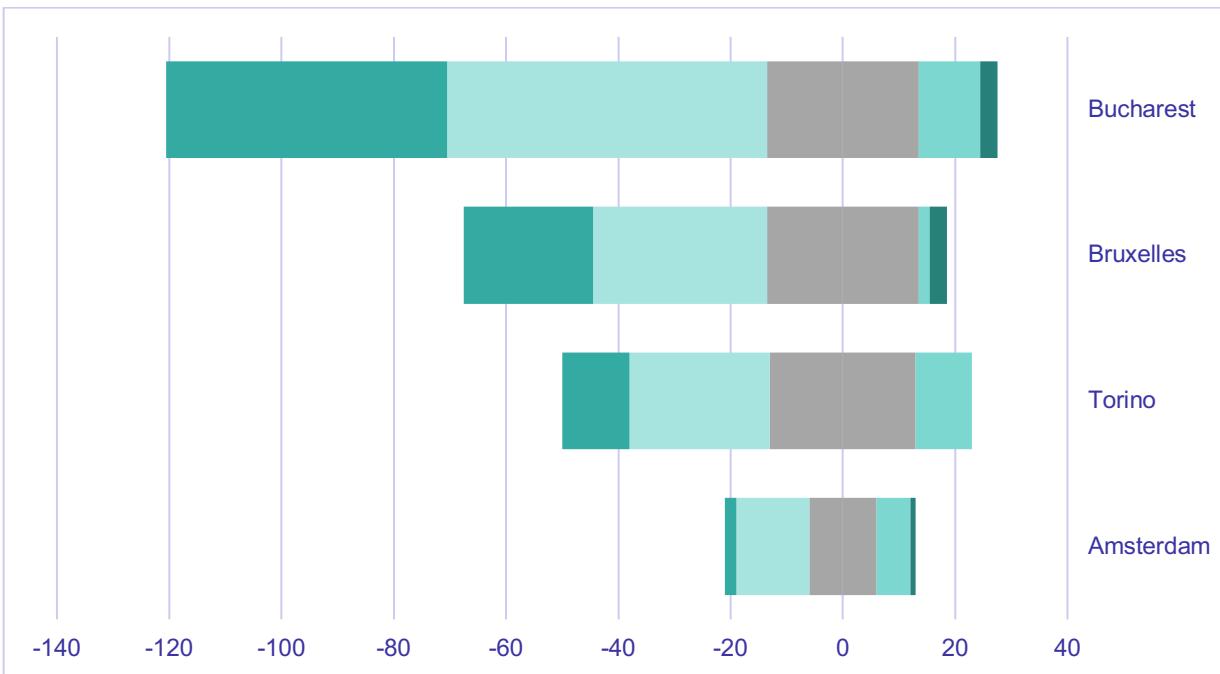
Figure 15. Perceptions of whether the needs of people with vulnerabilities are considered when addressing challenges around climate change (*agree and strongly agree* (right pale and dark turquoises); *undecided* (middle grey area); *disagree and strongly disagree* (left pale and dark turquoises)).

Environmental values in relation to nature-based solutions. The values that people hold for nature are multiple (*value pluralism*) (Hakkarainen et al., 2020) and they represent a crucial dimension of sustainable management of socio-ecological systems (Jones et al., 2016; Ostrom, 2009). These have been categorized into: self-transcendence (biospheric (nature-oriented) and altruistic (society-oriented)) and self-enhancement (egoistic (self-oriented) and hedonic (comfort-oriented)) (De Groot and Steg, 2007; Steg et al., 2012; Stern and Dietz, 1994). The biospheric values include concerns for nature and the natural environment (e.g., protecting the environment). The altruistic values reflect an interest in the welfare of other human beings (e.g., helpfulness). Egoistic values are associated with concerns about personal status (e.g., wealth). Hedonic values refer to pleasurable feelings as perceived by the users (e.g., people derive pleasure from engaging in recreation activities). Another type of values gained attention, the relational values, where the relationship between people and nature is more nuanced and the concern for nature represents a fundamental basis (Chan et al., 2016).

These types of values have been associated by the respondents in terms of their importance in relation to nature-based solutions (*Question 14*). In Bucharest and Turin the **altruistic values** referring to the importance of the benefits and accessibility delivered by NbS to people **gain a higher importance**, followed by **some biospheric and relational values** (Fig. 16, 17). Statements such as "*It is important that nature-based interventions contribute to the welfare of people (e.g., by improving health conditions for citizens, providing food, herbs,*

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beautifying/cooling homes and cities, reducing noise, providing shade, protecting against floods/wind)." (altruistic – helpful) (Bucharest M=4.77, SD=0.58; Turin M=4.70, SD=0.49) and „*It is important that nature-based interventions be accessible to all people, regardless of income, disabilities, gender, nationality, etc. (altruistic – equality)* (Bucharest M=4.75, SD=0.58; Turin M=4.73, SD=0.59) are highlighted as the most important*.*
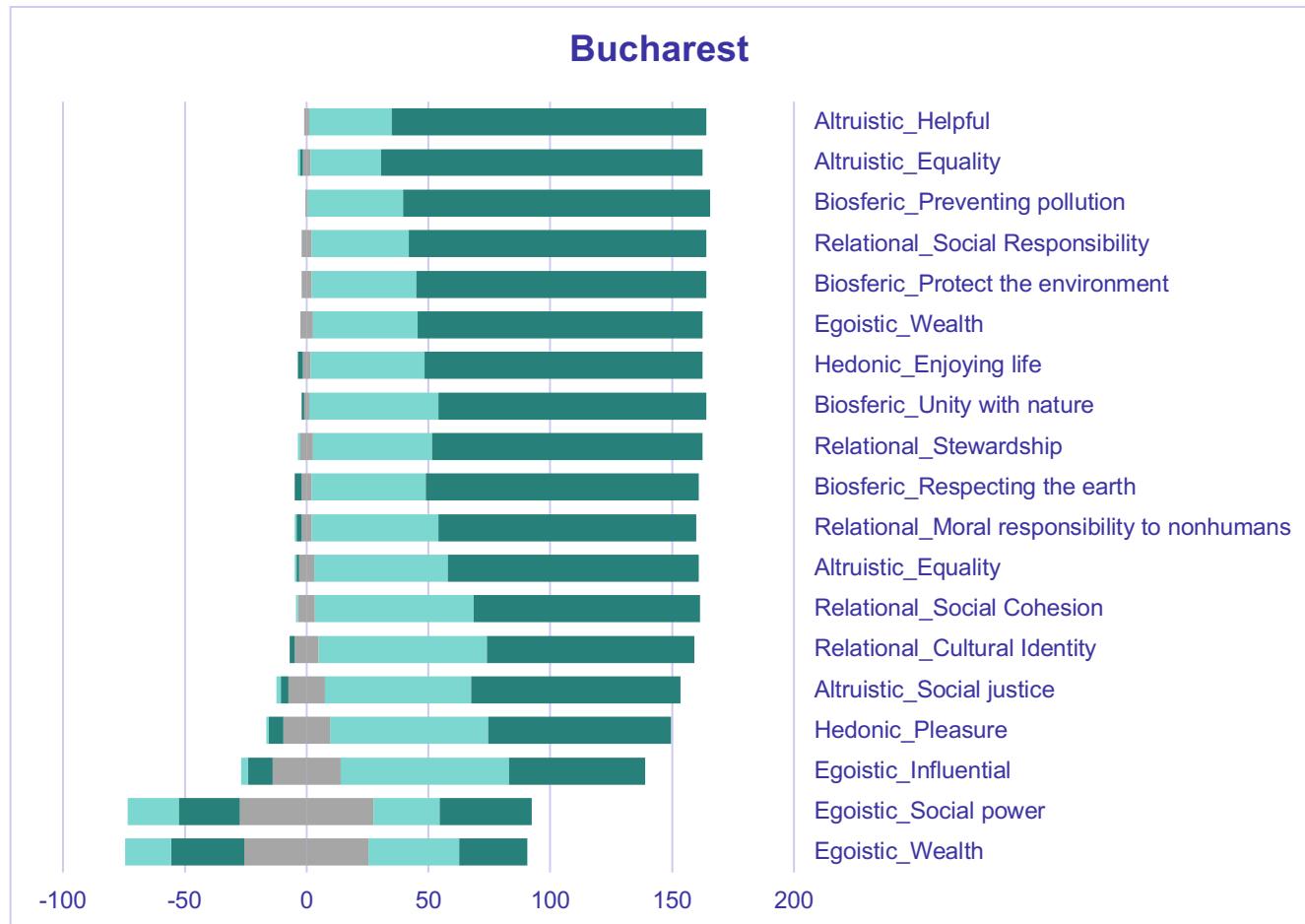
Figure 16. Environmental values associated with NbS in Bucharest: *agree and strongly agree* (right pale and dark turquoises); *undecided* (middle grey area); *disagree and strongly disagree* (left pale and dark turquoises).

Turin

Category
Altruistic_Equality
Altruistic_Helpful
Biosferic_Protect the environment
Relational_Social Responsibility
Biosferic_Preventing pollution
Biosferic_Respecting the earth
Relational_Stewardship
Altruistic_Equality
Biosferic_Unity with nature
Relational_Moral responsibility to nonhumans
Relational_Cultural Identity
Relational_Social Cohesion
Hedonic_Enjoying life
Egoistic_Wealth
Hedonic_Pleasure
Altruistic_Social justice
Egoistic_Influential
Egoistic_Wealth
Egoistic_Social power

Figure 17. Environmental values associated with NbS in Turin *agree and strongly agree* (right pale and dark turquoises); *undecided* (middle grey area); *disagree and strongly disagree* (left pale and dark turquoises).

In Amsterdam and Brussels prevail the **biospheric values** through which the importance of NbS for protecting the flora and fauna (to support biodiversity) is acknowledged (Amsterdam M=4.75, SD=0.48; Brussels M=4.79, SD=0.41) (Fig. 18, 19)). In Brussels, high importance is assigned to NbS's potential to support the well-being of future generations (M=4.82, SD=0.49), a **relational value** tied to the social responsibility.

Amsterdam

Biosferic_Protect the environment
Biosferic_Respecting the earth
Biosferic_Preventing pollution
Altruistic_Equality
Relational_Moral responsibility to…
Relational_Social Responsibility
Altruistic_Helpful
Relational_Stewardship
Biosferic_Unity with nature
Relational_Cultural Identity
Altruistic_Equality
Altruistic_Social justice
Hedonic_Pleasure
Hedonic_Enjoying life
Relational_Social Cohesion
Egoistic_Wealth
Egoistic_Influential
Egoistic_Social power
Egoistic_Wealth

Figure 18. Environmental values associated with NbS in *Amsterdam agree and strongly agree (right pale and dark turquoises); undecided (middle grey area); disagree and strongly disagree (left pale and dark turquoises).*

Brussels

Relational_Social Responsibility
Biosferic_Protect the environment
Altruistic_Equality
Altruistic-_Helpful
Relational_Stewardship
Relational_Moral responsibility to…
Biosferic_Respecting the earth
Altruistic_Equality
Biosferic_Unity with nature
Biosferic_Preventing pollution
Relational_Social Cohesion
Relational_Cultural Identity
Hedonic_Enjoying life
Altruistic_Social justice
Hedonic_Pleasure
Egoistic_Wealth
Egoistic_Influential
Egoistic_Social power
Egoistic_Wealth

Figure 19. Environmental values associated with NbS in Brussels *agree and strongly agree* (right pale and dark turquoises); *undecided* (middle grey area); *disagree and strongly disagree* (left pale and dark blue).

With regard to the differences between the professionals and non-professionals in each case study, in **Bucharest** the statements reflecting **biospheric** (*unity with nature - It is important that nature-based interventions offer opportunities for humans to connect with nature*) (M=4.81 for professionals, M=4.72 for non-professionals) and **altruistic** values (*helpful - It is important that nature-based interventions contribute to the welfare of people (e.g., by improving health conditions for citizens, providing food, herbs, beautifying/cooling homes and cities, reducing noise, providing shade, protecting against floods/wind)*) (M=4.79 for professionals, M=4.71 for non-professionals) were considered among the most important in both groups. Additionally, in the non-professional group a **relational** value linked to cultural identity (*It is important that nature-based interventions integrate community knowledge and values when they are designed*) (M=4.68) was included among the most important values.

In **Turin**, the statements reflecting **biospheric** (*protect the environment - It is important that nature-based interventions help protect the flora and fauna (support biodiversity)*) (M=4.70 for professionals, M=4.74 for non-professionals) and **altruistic** values (*equality - It is important that nature-based interventions be accessible to all people, regardless of income, disabilities, gender, nationality, etc.) (*M=4.68 for professionals, M=4.70 for non-professionals) were considered among the most important in both groups. Additionally, in the non-professional group a **hedonic** value reflecting pleasure (*It is important that nature-based interventions offer opportunities to have fun (i.e., playing games on the green street intervention: summer street; parklets*)) (M=4.74) was included among the most important values.

In **Amsterdam**, the **biospheric** (*preventing pollution - It is important that nature-based interventions prevent pollution (e.g., purifying air*)) (M=4.61 for professionals, M=4.78 for non-professionals) and **altruistic** (*equality - It is important that nature-based interventions be accessible to all people, regardless of income, disabilities, gender, nationality, etc.)* (M=4.50 for professionals, M=4.88 for non-professionals) statements were included among the most important in both groups.

In **Brussels**, the **altruistic** (*equality - It is important that nature-based interventions be accessible to all people, regardless of income, disabilities, gender, nationality, etc.)* (M=4.74 for professionals, M=4.84 for non-professionals) and **hedonic** values reflecting pleasure (*It is important that nature-based interventions offer opportunities to have fun (i.e., playing games on the green street intervention: summer street; parklets*)) (M=4.81 for professionals, M=4.84 for non-professionals) were included among the most important in both groups. Additionally, **biospheric** values such as "*It is important that nature-based interventions help protect the flora and fauna (support biodiversity)*" (M=4.85 for professionals) and "*It is important that nature-based interventions offer opportunities for humans to connect with nature*" (M=4.72 for non-professionals) were among the most important values.

Several socio-demographic factors may influence the expression of values. For example, a higher educational level was associated with a higher likelihood of expressing intrinsic and

relational values (Arias-Arevalo et al., 2017), and younger and females are bond emotionally (relational) with nature (Folmer et al., 2013). Furthermore, Sargisson et al., (2020) found opposite relationships between the socio-demographic factors and expression of values, compared to other studies. For example, they found that women/older respondents endorse altruistic and biospheric values, slightly more strongly than men/younger respondents (who endorsed egoistic values slightly more strongly). The influence of such factors on the expression of the above environmental values will be investigated using multivariate statistical analysis in further analyses.

IV. LESSON LEARNED

Based on the results of the survey, it would be important to:

- Integrate **professional expertise with citizen perspectives** in order to ensure **co-production** of climate risk knowledge and NbS planning.

Respondents with professional involvement in climate change and NbS related topics reported higher intensity for those climate risks which are the most common (e.g., heat, local temperature rise, storms, pluvial flooding). In contrast, non-professionals rate a higher intensity for less prominent risks (e.g., fluvial flooding, wildfire risks). While professionals might be guided by their formal expertise, and might choose those climate-related risks that are most frequently documented and assessed, the non-professionals might rely on their everyday specific experience and subjectivity. Aligning both expertise could enable implementable NbS.

Professionals report higher frequencies of NbS measures (for **flood** in all four cities, for **heat** in Bucharest and Turin) as they may have a greater familiarity with a wide spectrum of measures concerning these climate risks. Non-professionals report higher frequencies of NbS measures (for drought in Amsterdam, Turin and Brussels) as they might be more directly exposed to drought and thus report a broader range of measures that could mitigate this climate risk. Furthermore, in Bucharest and Turin the planning systems is more formal relying mostly on technical and expert-led approaches although there is an increasing community participation (Gradinaru et al., 2023; Mitincu et al., 2023). In contrast, in Amsterdam and Brussels more participatory and community led approaches are shaping the governance context and thus the non-professionals are more aware about a wide spectrum of NbS measures that could mitigate the climate risks.

- **Ensure co-creation and co-production of NbS** (73% in Bucharest, *71% in Turin have not been asked to be part of local discussions or have not contributed to city plans to make areas greener or more climate-adaptive*), especially those from vulnerable or marginalized groups who are underrepresented voices in planning and implementation (*over half of the respondents disagree, strongly disagree or don't know about the needs of people with*

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vulnerabilities being taken into consideration in all four case studies in the climate change discourse). Although, in Amsterdam and Brussels respondents exhibiting higher levels of participation in local discussions (48% reported participation, 43% reported absence of participation in Amsterdam; 43% reported participation, 51% reported absence of participation in Brussels) participation was limited to roughly half of the respondents, highlighting the need to reinforce co-creation and co-production mechanisms in NbS planning.

- **Build cross-sectoral partnerships** and promote evidence-based approaches to strengthen the governance of NbS, by working in partnership with local communities (*85% in Bucharest and 82% in Turin, 80% in Amsterdam and 72% in Brussels reported their voice is not being considered at all or are unsure about that*), research institutions and private sector to prioritize hotspots of vulnerability where NbS are needed.

- **Acknowledge the key values of residents** in Bucharest, Turin, Amsterdam and Brussels where an **increased prioritization of biospheric, altruistic and relational values over the egoistic and hedonic ones** has been observed. Other studies confirm this finding, for example Arias-Arevalo et al., (2017) when studying the perception of both urban and rural stakeholders over the ecosystems of a watershed and Hossu et al., (2024) when assessing the perception of residents engaged in the care and protection activities for urban green spaces.

V. REFERENCES

Arias-Arevalo, P., Martin-Lopez, B., Gomez-Baggethun, E., 2017. Exploring intrinsic, instrumental, and relational values for sustainable management of social-ecological systems. Ecology and Society 22. https://doi.org/10.5751/ES-09812-220443

Banaei, Z.A., 2024. Assessment of Nature-Based Solutions' Efficiency by Focusing on Justice at Urban Context of Turin and Amsterdam (Master Thesis). Politecnico di Torino.

Bandalos, D.L., Finney, S.J., 2018. Factor Analysis Exploratory and Confirmatory, in: The Reviewer's Guide to Quantitative Methods in the Social Science. Routledge.

BISA, 2025. Mini-Bru. Brussels-Capital Region in figures. Brussels Institute for Statistics and Analysis (BISA).

CBS, 2024. Population dynamics; birth, death and migration per region. [WWW Document]. URL https://www.cbs.nl/en-gb/figures/detail/37259eng

Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., Turner, N., 2016. Opinion: Why protect nature? Rethinking values and the environment. Proceedings of the National Academy of Sciences 113, 1462 LP – 1465. https://doi.org/10.1073/pnas.1525002113

Cheval, S., Amihăesei, V.A., Dumitrescu, A., Micu, D.M., Smău, R.-I., 2025. Observed Variability and Future Projections of Urban Heatwaves in Romania. International Journal of Climatology 45, e8714. https://doi.org/10.1002/joc.8714

De Groot, J.I.M., Steg, L., 2007. Value Orientations and Environmental Beliefs in Five Countries: Validity of an Instrument to Measure Egoistic, Altruistic and Biospheric Value Orientations. Journal of Cross-Cultural Psychology 38, 318–332. https://doi.org/10.1177/0022022107300278

Enu, K.B., Zingraff-Hamed, A., Boafo, Y.A., Rahman, M.A., Pauleit, S., 2024. Citizens' acceptability and preferred nature-based solutions for mitigating hydro-meteorological risks in Ghana. Journal of Environmental Management 352, 120089. https://doi.org/10.1016/j.jenvman.2024.120089

Essenfelder, A.H., Bagli, S., Mysiak, J., Pal, J.S., Mercogliano, P., Reder, A., Rianna, G., Mazzoli, P., Broccoli, D., Luzzi, V., 2022. Probabilistic Assessment of Pluvial Flood Risk Across 20 European Cities: A Demonstrator of the Copernicus Disaster Risk Reduction Service for Pluvial Flood Risk in Urban Areas. Water Econs. Policy 08, 2240007. https://doi.org/10.1142/S2382624X22400070

Ferreira, V., Barreira, A.P., Loures, L., Antunes, D., Panagopoulos, T., 2021. Stakeholders' perceptions of appropriate nature-based solutions in the urban context. Journal of Environmental Management 298, 113502. https://doi.org/10.1016/j.jenvman.2021.113502

Folmer, A., Haartsen, T., Huigen, P.P.P., 2013. Explaining Emotional Attachment to a Protected Area by Visitors' Perceived Importance of Seeing Wildlife, Behavioral Connections with Nature, and Sociodemographics. Human Dimensions of Wildlife 18, 435–449. https://doi.org/10.1080/10871209.2013.811618

Gradinaru, S.R., Onose, D.A., Oliveira, E., Slave, A.R., Popa, A.M., Gravrilidis, A.A., 2023. Equity in urban greening: Evidence from strategic planning in Romania. Landscape and Urban Planning 230, 104614–104614. https://doi.org/10.1016/J.LANDURBPLAN.2022.104614

Hakkarainen, V., Anderson, C.B., Eriksson, M., van Riper, C.J., Horcea-Milcu, A., Raymond, C.M., 2020. Grounding IPBES experts' views on the multiple values of nature in epistemology, knowledge and collaborative science. Environmental Science & Policy 105, 11–18. https://doi.org/10.1016/j.envsci.2019.12.003

Hossu, C.A., Artmann, M., Saito, T., Van Lierop, M., Ioja, C.I., Pauleit, S., 2024. Understanding residents' engagement for the protection of urban green spaces by enriching the value-belief-norm theory with relational values—A case study of Munich (Germany). People and Nature 6, 1538–1555. https://doi.org/10.1002/pan3.10654

ISTAT, 2024. Bilancio demografico [WWW Document]. URL https://demo.istat.it/app/?i=P02&l=it (accessed 12.23.25).

Jones, N.A., Shaw, S., Ross, H., Witt, K., Pinner, B., 2016. The study of human values in understanding and managing social-ecological systems. Ecology and Society 21. https://doi.org/10.5751/ES-07977-210115

Khodadad, M., Sanei, M., Aguilar-Barajas, I., Cárdenas-Barrón, L.E., Ramírez-Orozco, A.I., Rizzo, A., Khan, A.Z., 2025. Green infrastructure site prioritization to improve urban flood resilience in Monterrey and Brussels using a decision support model. Scientific Reports 15, 10744. https://doi.org/10.1038/s41598-025-94851-z

Maas, A., 2024. Urban heat in Amsterdam, forecasting indoor temperatures. Developing an indoor temperature forecasting model using citizen science. Wageningen University.

Mabon, L., Barkved, L., de Bruin, K., Shih, W.Y., 2022. Whose knowledge counts in nature-based solutions? Understanding epistemic justice for nature-based solutions through a multi-city comparison across Europe and Asia. Environmental Science & Policy 136, 652–664. https://doi.org/10.1016/J.ENVSCI.2022.07.025

Mitincu, C.G., Grădinaru, S.R., Iojă, I.C., Hartel, T., van Lierop, M., Hossu, C.A., 2023. The public consultation is open: Insights from urban green infrastructure planning in Romania. Urban Forestry & Urban Greening 86, 127985–127985. https://doi.org/10.1016/J.UFUG.2023.127985

Ostrom, E., 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science 325, 419–422. https://doi.org/10.1126/science.1172133

Pânzaru, D.M.R., Iojă, I.-C., Pleșoianu, A.-I., Hossu, C.-A., Diaconu, D.-C., 2022. Nature-based solutions for urban waters in Romanian cities. Nature-Based Solutions 2, 100036. https://doi.org/10.1016/j.nbsj.2022.100036

Patroescu, M., Nita, M., Ioja, C., Vanau, G., 2009. New residential areas in Bucharest Metropolitan Area – location, type and characteristics, in: Real Corp Procedings.

Petrișor, A.-I., Mierzejewska, L., Mitrea, A., 2022. Mechanisms of Change in Urban Green Infrastructure; Evidence from Romania and Poland. Land 11. https://doi.org/10.3390/land11050592

Sargisson, R.J., De Groot, J.I.M., Steg, L., 2020. The Relationship Between Sociodemographics and Environmental Values Across Seven European Countries. Frontiers in Psychology.

Steg, L., Perlaviciute, G., van der Werff, E., Lurvink, J., 2012. The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. Environment and Behavior 46, 163–192. https://doi.org/10.1177/0013916512454730

Stern, P.C., Dietz, T., 1994. The Value Basis of Environmental Concern. Journal of Social Issues 50, 65–84. https://doi.org/10.1111/j.1540-4560.1994.tb02420.x

VI. DISSEMINATION ACTIVITIES

Participation at international conferences

- Niță M.R., Hossu C.A., Iojă C.I., Calotă A.M., Mitincu C.G., 2025, Showcasing experiences from GREEN-INC survey on stakeholders' perceptions of risks and NbS acceptance, SURE Workshop: Green Together: Building Climate-Resilient Urban Nature through Participation, Bucharest, 23-25 October, Bucharest, Romania.

- Niță M.R., Hossu C.A., Iojă C.I., Calotă A.M., Mitincu C.G., 2025, *Evaluating stakeholders' perception for inclusive climate actions and NBS acceptance*, EGU General Assembly 2025, 27th April – 2nd May, Vienna, Austria.

- Mitincu C.G., Hossu C.A., Calotă A.M., Niță M.R. Iojă C.I., 2025, *Inclusive nature-based solutions for local communities: Lessons from European case studies*, 11th ESP World Conference, 23th – 27th, Darwin, Australia.

- Calotă A.M., Niță M.R., Hossu C.A., Mitincu C.G., Iojă C.I., 2025, *Towards Inclusive Nature-based Solutions: Criteria for Equitable Implementation of Nature Based-Solution in cities*, IALE 2025 European Landscape Ecology Congress, 2nd – 5th September, Bratislava, Slovacia.

- Iojă C.I., Calotă A.M., Hossu C.A., Niță M.R., Matache L.M., 2025, *Nature-based Solutions Urban Living Lab Tei-Colentina*, 13th International Conference on Environmental Engineering and Management (ICEEM), 17-20 September, Iasi, Romania.

- Mitincu C.G., Hossu C.A., Calotă A.M., Niță M.R. Iojă C.I., 2025, *Inclusive nature-based solutions in urban ecosystems: Lessons learned from case studies across Europe*, 8th Scientific Symposium "Ecosystem Services in a Transdisciplinary Approach", 18th -25th September, Poznan, Poland.

- Calotă A.M., Iojă C.I., Hossu C.A., Niță M.R., Matache L.M., 2025 *Resilient by Nature — Stakeholder-driven blue approaches in the Tei-Colentina Living Lab*, 2nd Conference on Water Research for Young Scientists, 22-23 September, Bucharest, Romania.

APPENDIX I

The Survey on Valuation of Interventions that use Nature to Address Climate Risks

Question	Answer
The socio-demographic profile	
1. How would you describe your professional or non-professional involvement with climate change and nature-based interventions in your city?	I work professionally in this field (e.g., policymaker, urban planner, environmental consultant, NGO staff, academic researcher, etc.) / I have some professional or academic background related to these topics, but it's not my main job / I am not professionally involved, but I am personally interested or active (e.g., community member, volunteer, student, etc.) / I have little or no experience or knowledge in this area
2. Age	19-35 / 36-50 / 51-65 / over 65
3. Gender	Female / Male / Other / I do not want to disclose
Societal challenges and exposure to climate risks	
4. What are the challenges that your city is currently facing? (choose up to five options)	Air pollution / Heatwaves and global temperature rise / Intense rainfall and floods / Extreme wind / The intrusion of invasive species (i.e., insects and plants) / Loss of biodiversity / Low quantity of green spaces / Low quality of green spaces / Degraded areas / Vacant lands / Low aesthetic quality of the urban landscape / Lack of spaces for outdoor leisure activities and relaxation / Heavy traffic / Degradation of water quality / Rapid land take/urbanization / Wildfire risk / Sea level rise / Vector-borne diseases (i.e., insects) / Drought and water scarcity/ Other
5. What are the climate risks that your city is currently facing? Heatwaves / Local temperature rise / Heavy storms / Drought and water scarcity / Intense rainfall / Pluvial Flooding / Fluvial flooding / Sea level rise / Wildfire risk / Other, please specify	Vey intensive / Quite intensive / Neutral / Little intensive / Not intensive / Not applicable to my city
6. Have you experienced any negative impact related to any of the above climate risks?	No / Yes. Which impacts? (open question)
Preference for and acceptance of nature-based solutions	
7. Which of the listed nature-based interventions would contribute to address the following climate risks? Street trees / Tree planting / Green roofs and green walls / Green barriers / Urban forest / Lawns / Permeable paving / Gardens and community gardens / Wetlands and waterbodies (ponds, lakes) / Constructed wetlands / Rain gardens & bioswales / Urban agriculture / River conservation/restoration / Floodable parks / Rainwater harvesting / Agroforestry	Heat / Flood risk / Drought / I cannot assess its contribution
8. Have you noticed any of the following interventions being prioritized to mitigate climate risks in your city?	Tree planting, river restoration, permeable paving, green roofs, community gardens *(interventions using nature)* / Use of air conditioners, mobile apps for climate risks, heat resistant rooftops (non-vegetative) *(interventions using constructed structures)* / Unsure / No interventions / Other (please specify)
9. Are enough nature-based interventions (e.g., tree planting, green roofs, green corridors, gardens, etc.) in your residential area?	Fully agree / Agree / Partly agree / Disagree / Strongly disagree / Don't know

10. Have the nature-based interventions (those you were thinking of when answering to the previous question) influenced how people interact in your district?	Yes. Please specify (e.g., meeting with friends, neighbors) / No / Not applicable
Aspects of inclusivity and social equity	
11. Have you been asked to be part of local discussions or contributed to city plans to make areas greener or more climate adaptive?	Yes / No
12. Do you feel your voice is considered?	Yes / Unsure / No / Not applicable
13. Do you feel that the needs of people with vulnerabilities (e.g., people with disability, having a migrant background, or being older) are taken into consideration when addressing challenges around climate change?	Fully agree / Agree / Partly agree / Disagree / Strongly disagree / Don't know
Environmental Values	
14. Please indicate to what extent you consider the following statements relevant for the nature-based interventions (e.g., green corridors, gardens, green roofs, etc.)?	

Biospheric - 4 statements

Preventing pollution (protecting natural resources) It is important that nature-based interventions prevent pollution (i.e., purifying air.	5 = Strongly agree 4 3 2 1 = Strongly disagree
Protect the environment (preserving nature) It is important that nature-based interventions help protect the flora and fauna (support biodiversity).	
Respecting the earth (harmony with other species): It is important that nature-based interventions allow living in harmony with other species (i.e., birds, squirrels).	
Unity with nature (fitting into nature): It is important that nature-based interventions offer opportunities for humans to connect with nature.	

Altruistic - 4 statements

Equality (equal opportunity for all) It is important that nature-based interventions be accessible to all people, regardless income, disabilities, gender, nationality etc.	5 = Strongly agree 4 3 2 1 = Strongly disagree
Social justice (correcting injustice, care for the weak) It is important that nature-based interventions help people feel more connected to each other.	
A world at peace (free of war and conflicts) It is important that nature-based interventions help ease tensions between human needs and the natural world.	
Helpful (working for the welfare of others) It is important that nature-based interventions contribute to the welfare of people (i.e., by improving health conditions for citizens, providing food, herbs, beautifying/cooling homes and cities, reducing noise, providing shade, protecting against flood/wind).	

Egoistic – 4 statements

Social power (control over others, dominance) It is important that nature-based interventions offer safety by limiting access to certain categories of people.	5 = Strongly agree 4 3 2 1 = Strongly disagree
Wealth (material possessions, money) It is important that nature-based interventions offer a low-cost day out. It is important that nature-based interventions contribute to increased property value.	
Influential (having an impact on people and events) It is important that nature-based interventions create jobs and income.	

Hedonic – 2 statements

Pleasure (gratification of desires) It is important that nature-based interventions offer opportunities to have fun (i.e., playing games on the green street intervention: summer street; parklets).	5 = Strongly agree 4 3 2 1 = Strongly disagree
Enjoying life (enjoying leisure) It is important that nature-based interventions offer leisure opportunities (i.e., walking, cycling).	
Relational – 5 statements	
Social cohesion It is important that nature-based interventions contribute to the pleasure and well-being of people (offering the opportunity to socialize through nature).	5 = Strongly agree 4 3 2 1 = Strongly disagree
Social responsibility It is important that nature-based interventions be employed to improve the well-being of future generation, of our children.	
Cultural identity It is important that nature-based interventions integrate community knowledge and values when they are designed.	
Moral responsibility to non-humans It is important that nature-based interventions honor the intrinsic value of all life forms (human and non-human).	
Stewardship It is important that nature-based interventions embody care and responsibility, and sustainable interactions between humans and the environment.	