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Tool Used to Assess Co-Benefits of Nature-Based Solutions in Urban Ecosystems for Human Wellbeing: Second Validation via Measurement Application

Karmele Herranz-Pascual [1,*,†], Paula Anchustegui [2,*,†], Carolina Cantergiani [1] and Ioseba Iraurgi [3]

[1] TECNALIA-Basque Research and Technology Alliance, Parque Científico y Tecnológico de Bizkaia, Astondo Bidea, Edificio 700, 48160 Derio, Spain; carolina.cantergiani@tecnalia.com
[2] Faculty of Psychology, University of Barcelona, Pg. de la Vall d'Hebron, 171, Horta-Guinardó, 08035 Barcelona, Spain
[3] Faculty of Health Sciences, University of Deusto, 48007 Bilbao, Spain; ioseba.iraurgi@deusto.es
* Correspondence: karmele.herranz@tecnalia.com (K.H.-P.); panchuig141@alumnes.ub.edu (P.A.)
† These authors contributed equally to this work.

Abstract: In recent years, nature-based solutions have been used in urban regeneration interventions to improve the adaptation and resilience of these places, contributing to improved environmental quality and cultural ecosystem functions, including people's physiological, social, and mental health and wellbeing. However, when it comes to the assessment of psychological wellbeing and social benefits (psychosocial co-benefits), the existing evidence is still limited. To contribute to the advancement of knowledge on nature's contribution to people in relation to this type of benefit, it is necessary for us to develop and test assessment tools to contribute to the development of a robust nature-based solutions monitoring framework. In this paper, the second phase of the validation of a psychosocial co-benefit assessment tool for nature-based urban interventions is presented. This tool is structured around two dimensions: the perceived health and wellbeing and social co-benefits. The first validation was carried out with experts using the Delphi method. The second validation presented in this paper was based on a sample of users, evaluating a set of eight urban spaces at different levels of naturalisation and openness. The results indicate that the tool is sensitive to the differences in naturalisation and openness in the public urban places analysed. The most relevant contextual variables to explain the psychosocial co-benefits are openness, the surfaces covered by tree branches, the water surface area, and naturalisation.

Keywords: nature-based solutions; climate change adaptation; nature's contribution to people; psychosocial benefits; health and wellbeing; cultural ecosystem services; urban spaces

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1. Introduction

This study contributes to the advancement of impact assessments of nature-based solutions for human wellbeing and cultural ecosystem functions in urban settings. This aim is related to three of the following Sustainable Development Goals (SDGs), which are a part of the 2030 Agenda for Sustainable Development adopted by all United Nations Member States in 2015 [1]: SDG3, which focuses on good health and wellbeing; SDG10, which aims to reduce inequalities; and SDG11, which focuses on supporting sustainable cities and communities.

Sustainable communities refer to human settlements, such as cities, megacities, large towns, and small towns. In the last decadesthe continued increase in urbanisation [2],

mostly in developing countries, has created important global policy debates around urban settings.

1.1. Current Urban Development

Experts in diverse fields have revealed the impacts that urban areas have on various aspects of human life and non-human life [3], such as those related to climate change, economic growth, poverty, housing, infrastructure, basic services, jobs, quality of life, food security, and public health [4]. All these aspects are very relevant in everyday life and in sustainable future.

That being true, little attention is paid to these concepts when planning or designing urban structures. Therefore, recent decades, have been characterised by the increasing artificialisation of urban spaces, with more space for cars and transport than that for residents, and few open spaces that are widely thought of as safe and comfortable for human interaction [5]. Moreover, by not considering the importance and effects of spaces, urban development policies focusing solely on economic growth have not always brought about a reduction in poverty and inequality. However, when approached correctly, urban spaces can represent a great tool to eradicate these issues [6] within populations and social groups that are vulnerable and under-represented.

Luckily, each day, more experts emphasise the importance of a thoughtful urban development plan that benefits both the current residents and future generations, especially vulnerable groups (from now on, social and environmental justice will be referred to as socio-environmental justice). When designing urban spaces, it is often forgotten that human beings need nature and natural surroundings to live [7].

1.2. Nature-Based Solutions: The Power of Nature in Urban Spaces

In an attempt to close the gap between the way in which urban development has been carried out to date and the evolutionary and biological needs of humans in urban spaces, experts in diverse fields have found Nature-based Solutions (NbSs) to be a good approach to climate change adaptation. It is associated with the improvement of wellbeing, equality, and sustainability in communities in urban and currently artificialized spaces that are not conducive to building relationships [8]. NbSs represent integrated, sustainable, and innovative solutions for climate change adaptation that enhance the capacity and flow of ecosystem services by protecting and restoring natural ecosystems and the environment [9].

Experts from different backgrounds have viewed NbSs through various disciplinary lenses. Dorst et al. [10] described NbSs as "interventions based on nature that are envisaged to address sustainability challenges such as resource shortages, flood and heat risks and ecosystem degradation caused by processes of urbanisation and climate change". Kabisch et al. [11] underlined the connection of NbSs with "the maintenance, enhancement, and restoration of biodiversity and ecosystems as a means to address multiple concerns simultaneously". In contrast, Frantzeskaki et al. [12] viewed NbSs in a social-ecological context, noting that "transition initiatives as actor configurations that establish, experiment, and localise nature-based solutions shift them from 'solutions' to social configurations, making nature-based solutions the new 'urban commons of sustainability'". Overall, NbSs are associated with environmental aspects, such as climate resilience, water management, biodiversity enhancement, air quality, and place regeneration. There have been some attempts to create tools that evaluate these environmental aspects, and they have been shown to be effective [13]. Nevertheless, NbSs also have other—often forgotten—impacts on human health and wellbeing.

1.3. Nature and Benefits for People's Health and Wellbeing

Various researchers have come to the conclusion that the natural environment (green and blue surfaces) supports health and wellbeing in human populations [14]. On the one hand, there are physiological, social, psychological, and cognitive aspects related to air quality, physical activity, and stress reduction. On the other hand, natural environments and green spaces also offer a sense of emotional attachment to places and the development of relational values that underpin environmental stewardship [15].

Moreover, research indicates that exposure to the elements of nature has a positive effect by eliciting feelings of joy, respect, and wonder; fostering feelings of comfort and friendliness; promoting intrinsic aspirations and generosity; and increasing vitality [16].

1.4. Nature and Cultural Functions in Urban Ecosystems

Another aspect of urban spaces that is often forgotten is how they allow the cultural functions of ecosystems to develop [17]. These public spaces serve as the birthplace of social relations. The acquisition of different social practices that constitute someone's social life take place most of the time in specific spaces; human behaviour does not happen in a vacuum. These physical environments greatly influence the establishment of social relations [16]. Individuals will perform and exhibit different types of interaction depending on whether they are in the workplace, at home, at a restaurant, or in a hospital.

Urban public spaces are also the place where social practices are learnt and exhibited, where cultural aspects are performed and shared, and where social groups are created. These are spaces that greatly define a person's individuality and are where social and place identities are formed [18].

Psychosocial aspects, such as place-related identity, social justice, social cohesion, and health and wellbeing, are focused more on the ways in which the residents of an urban area feel when using their environment.

1.5. Psychosocial Benefits of Nature in Urban Settings

Making a change in an urban setting will surely affect its residents, as the space will shape human interactions, social configurations, and moods [16]. This is the key reason why we should take into account how extensively nature and its components impact people's everyday lives. Some studies have reported links between individual health outcomes and a connection with nature in domains as varied as the physical, social, cognitive, emotional, and spiritual domains. Some examples include disease improvement or prevention, such as a reduction in type 2 diabetes, improved cardiovascular health, and brain growth [19]. Other studies have shown that a connection with and exposure to nature reduces anxiety and stress and restores attention [20], and individuals have reported an improvement in their emotional regulation [21]. Even exposing oneself to nature unconsciously, as seen in children, has benefits, such as in concentration and motor ability [22]. In addition to all these individual benefits of nature exposure, implementing NbSs with residents in mind will also lead to more green and peaceful areas where residents can interact with one another, creating bonds, which are essential in humans [23], and enhancing a community feeling, which then can evolve into more and deeper interactions between residents, prosocial behaviours, and a general feeling of safety in urban areas. However, these psychosocial aspects, although greatly impactful, have been shown to be more difficult to assess and evaluate [8].

1.6. The Evaluation of Psychosocial Co-Benefits

In an attempt to find better ways to evaluate the psychosocial benefits of NbSs, researchers have turned to the meta-principles and principles of Regenerative Sustainability

(RS) [24], an approach to the environmental crisis that seeks to actively improve ecological health, drawing inspiration from nature's inherent ability to heal and sustain itself. RS aims to create processes that are not just sustainable, but also beneficial to the environment, effectively contributing to the regeneration of ecosystems and communities.

Combining the principles of RS and the research around NbSs, some researchers have begun to acknowledge the importance of measuring the psychosocial impacts of NbSs and address the lack of existing tools and methods.

One of the most recent examples is the tool for NbS psychosocial co-benefit assessment (the NbS-CoBAs tool for short), which assesses nature's contribution to people in urban spaces, including the urban regeneration process [25]. It is a tool for the users of urban public spaces. The NbS-CoBAs tool, created within the CLEVER-Cities project, was validated through the Delphi method with an expert sample. This tool is made up of 24 items that refer to 13 attributes. Two of them are associated with health benefits: perceived general health and the ability to facilitate physical activity. The others are related to psychosocial co-benefits, such as a feeling of belonging, socio-environmental justice, social cohesion, participation, satisfaction with a place, the perceived safety of a place, social flow, and the ability to generate changes in emotional state. In addition, there are three attributes that refer to general dimensions: subjective wellbeing, the restorative capacity of a place, and the environmental comfort of a place.

After the expert validation of this tool was conducted, we thought it necessary to validate it by applying it to real urban spaces, which is the objective of this article. With this aim in mind, eight urban spaces were chosen with different levels of naturalisation and openness in order to evaluate the tool's sensitivity in assessing these differences.

There are three hypotheses in this study: (1) The degree of naturalisation of the urban places has a positive influence on the psychosocial co-benefits. (2) The degree of openness of places also has a positive impact on the co-benefits. Finally, (3) naturalisation is more associated with co-benefits than openness.

2. Materials and Methods

This section describes the participants and places involved in tool validation, gives an overview of the characteristics of the questionnaire itself, and explains the procedure followed to carry out validation.

2.1. Selection of Places

Eight places were selected for validation of the tool. The main criterion for the selection of these spaces was their different degrees of naturalisation and openness, as the objective was to validate the NbS-CoBAs' sensitivity to the presence of natural elements in urban surroundings, as well as their differential impacts on NbS co-benefits.

In addition, the places were localised in a single neighbourhood in a coastal Cantabrian city (Spain). The chosen places were very close to one another, which allowed for the assumption that there would be similar sociodemographic and socio-cultural variables affecting the evaluation of these places.

Below, a brief description of these places is given:

- Place 1: Wide and open green spaces, with paved paths to walk around, and there are also trees, and benches.
- Place 2: A green space with trees, benches, and a small lake, which is situated below ground level.
- Place 3: Wide space with green and blue areas, trees, walking paths and benches. It is surrounded by buildings, roads, and shops area.

- Place 4: Not wide and not open small, green space, with a children's park, surrounded by buildings in a neighbourhood-like place.
- Place 5: Wide space surrounded by buildings and a sports centre. No green spaces, a park with changing flower beds, bars, padded floors, or benches.
- Place 6: Not open, surrounded by buildings, within a neighbourhood, and with two differentiated spaces. One is green with trees and a paved path for walking, and the other is a fun park for children with benches.
- Place 7: Wide courtyard with benches, some small, green spaces with trees, and a children's park, and surrounded by buildings.
- Place 8: Wide, green space surrounded by large, although not very tall, buildings, with a cafeteria in the central part and places to play ping-pong, trees and benches and wide paved paths.

Out of these eight places, three are urban parks (places 1, 2, and 8), two are wide and open squares (places 3 and 5), and the rest are small squares without traffic, delimited by high buildings in a block (courtyard; places 4, 6, and 7).

Table 1 summarises some of the characteristics of these sites, such as the surface (m^2); the number of sides of the place with road traffic (RT); the presence of a playground (PG); and the presence of bars or terraces (B&Ts), shops, or educational buildings (EBs), the sum of which could indicate the diversity of local services.

Table 1. Context characteristics of evaluated places.

		Surface	Presence					
Places	**Type**	**(m^2)**	**RT**	**PG**	**B&T**	**Shops**	**EB**	**Sum**
1	park	27.135	1	yes	no	no	no	1
2	park	9.730	5	no	no	no	no	0
3	plaza	7.908	3	no	yes	yes	no	2
4	courtyard	2.620	0	no	no	no	yes	1
5	plaza	2.550	2	no	yes	no	yes	2
6	courtyard	3.855	0	yes	no	no	no	1
7	courtyard	2.112	0	yes	no	no	no	1
8	park	11.605	1	no	yes	no	yes	2

RT, the number of sides of the place with road traffic; PG, the presence of a playground (yes/no); B&T, the presence of bars or terraces (yes/no); shops, the presence of shops (yes/no); EB, the presence of educational buildings (yes/no); sum, the total presence of the previous elements.

Apart from these context variables, it was considered necessary to obtain an independent evaluation of the degrees of naturalisation and openness of the spaces due to their relevance to the hypothesis of this study. With that in mind, five experts (who came from a varied set of fields, such as geography, environmental sciences, urbanism, and environmental psychology) were asked to evaluate a set of indicators, as well as the degrees of naturalisation and openness of the spaces.

These indicators consisted of the percentage of green/earth surfaces (%Green), the percentage of the surfaces that had water elements (%Blue), and the percentage of artificial surfaces (%Grey), as well as the percentage of the surfaces that were covered with tree branches from an aerial view (%Trees). The combined percentage of the first three indicators should amount to 100. To perform the evaluation, we used images available in Google Maps. The closest buildings and/or roads delimited the chosen places. Moreover, the experts were asked to estimate the degrees of naturalisation and openness, as mentioned before, on a scale from 0 (the absence of the characteristic) to 10 (the maximum presence of the characteristic). Table 2 shows the mean values of the experts' estimations.

Table 2. The mean values of the expert (n = 5) estimates of the percentages of areas occupied by green (%Green), blue (%Blue), and grey (%Grey) surfaces and tree canopies (%Trees), as well as the mean values for the naturalisation and openness of the places.

			Percentage		Degree	
Place	**%Green**	**%Blue**	**%Grey**	**%Trees**	**Nature**	**Openness**
1	86.80	0.00	13.20	25.00	7.3	7.6
2	76.50	14.89	8.61	70.00	7.8	5.0
3	50.15	8.62	41.23	29.00	3.6	7.3
4	10.20	0.00	89.80	5.60	1.4	2.9
5	2.60	0.00	97.40	0.40	0.7	6.6
6	72.13	0.40	27.47	48.00	4.4	4.3
7	47.88	0.00	52.12	45.00	4.1	3.8
8	85.64	0.00	14.36	14.00	5.0	8.4

%Green, percentage of green surface/earth surface; %Blue, percentage of surface with water elements/earth surface; %Grey, percentage of artificial surface/earth surface; %Trees, percentage of total surface covered with tree branches in an aerial view; nature, the average score for naturalisation (scale 0–10); openness, the average score for openness (scale of 0–10).

2.2. Participants

This work included a sample of 115 participants. The sample was balanced regarding the gender of the participants, with 51.1% being women.

The participants were students in the final year of a course in geography (GEO), urban design (TEC), or psychology (PSY). Their average age was 21.51 years (SD = 4.89), and 80% were between 19 and 22 years old. The participants were divided into three groups, depending on the course that they were studying, all of which were related to the environment in some way:

1. GEO: Geography students (26.5% of the participants). All the participants in this group were male (100%), with an age average of 22.51 (SD = 3.06) years old.
2. TEC: Urban design students from a Technological University (52.4% of the participants). This group had similar percentages of male and female students (41.9% male and 58.1% female), with an average age of 21.48 (SD = 6.84) years old.
3. PSY: Psychology students (21.1% of the participants). All the members of this group were female (100%), and the average age was 21.3 (SD = 1.12) years old.

The distribution of these groups by gender indicates the existence of significant differences($\chi^{2(2)} = 213.78$; $p < 0.001$), but not by age ($F(2;97) = 0.145$; $p = 0.865$).

The participants (n = 115) carried out a total amount of 437 valid evaluations, which comprised analysis units.

The evaluations were distributed homogeneously between the analysed spaces (8–16%), except for three of them: place 1 (4.6%), place 3 (4.8%), and place 6 (28.8%). These differences may be due to the routes that the different sample groups took while they were completing the questionnaire.

Most of the participants performed between one and six evaluations, being less likely to perform seven (2.6%) or eight (7.0%). The mean was 3.80 (SD = 2.13) evaluations. Table 3 shows the number and percentage of participants and evaluations carried out, with the range being from one to eight.

Table 3. Number and percentage of participants and evaluations in different places evaluated and in whole study.

		Places								Total
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Participants	N	20	17	23	12	11	21	3	8	115
	%	17.39	14.78	20.00	10.43	9.57	18.26	2.61	6.96	100
Evaluations	N	20	34	69	48	55	126	21	64	437
	%	4.58	7.78	15.79	10.98	12.59	28.83	4.81	14.65	100

2.3. Questionnaire

As mentioned previously, the tool, named NbS-CoBAs, was used to measure the co-benefits of nature-based solutions in urban areas. The questionnaire was made up of 24 items that referred to 13 attributes of the co-benefits of NbSs, which refer to two general dimensions (see "Supplementary Materials"):

- Perceived General Health: The attributes in this group consisted of perceived general health and physical activity facilitation capacity.
- Psychosocial Health: The attributes in this group included a sense of belonging, socio-environmental justice, social cohesion, participation, perceived safety, the capacity to generate changes in emotional state, and social flow.
- Perceived General Health and Psychosocial Health: The attributes in this group were subjective wellbeing, restorativeness, place satisfaction, and environmental comfort (which consisted of the perception of visual, acoustic, thermal, light, and global comfort).

This questionnaire was previously validated by an expert panel using the Delphi method [25]. Nevertheless, the validation process showed that the average inter-rater agreement for the final version of the scale was 86.5% for face validity. The agreement range was between 50% and 100%, and in 95% of the items, the inter-rater agreement was higher than 80%. Regarding content validity, the average inter-rater agreement was found to be 88.5% (with an agreement range between 70% and 100%).

It should be mentioned that in this validation process, the indirect items in the questionnaire (those regarding social cohesion, participation, place satisfaction, and socio-environmental justice) were not taken into account, for these items can only be properly interpreted when the participants filling the questionnaire are (or have been) long-term residents of the neighbourhood. For the same reason, the items regarding the dimensions of physical activity facilitation capacity and sense of belonging were omitted.

After these considerations, for this paper, we analysed five dimensions:

1. Perceived safety, which referred to perceived safety during daytime and during night-time (2 items).
2. The capacity to generate changes in emotional state, which was evaluated using a single item.
3. Social flow, which was also redacted to a single item.
4. Restorativeness, which was defined by four fundamental dimensions: (1) "being away", a series of perceived characteristics that allow for individuals to distance themselves physically or psychologically from concerns that require their directed attention; (2) "fascination", the perceived characteristics that attract people's attention; (3) "extent", the environmental qualities that invite exploration beyond what is immediately perceived; and (4) "compatibility", the perception that the environment is consonant with the goals of the person experiencing it. In this study, four items were selected, one for each of the dimensions [26].

5. Environmental comfort, which referred to the general environmental comfort of the place users, as well as the specific comfort in relation to visual, acoustic, thermal, and light components.

In Table 4, the characteristics of these dimension are shown as the attributes, the number of items, statements, and response scales, as well as the apparent and content validity of these assessment scales.

Table 4. The characteristics of the assessment scales for the five dimensions evaluated in this study.

Dimensions	Attributes	n	Statement	Response Scale	Apparent Validity	Content Validity
Perceived Safety	(1) During the day (2) During the night	2	In general, how safe or secure do you feel walking or being in this place during the day/night?	1, not confident at all; 2, not very confident; 3, moderately confident; 4, fairly confident; 5, very confident.	90–100	100
Capacity to Generate Changes in Emotional State:	Emotional change	1	To what extent does being in this place cause you to change your emotional state (joy, calm, anger, etc.) in any way?	Ordinal 5-point scale: never (1), sometimes (2), quite often (3), most of the time (4), always (5).	80	100
Social Flow	Social flow	1	When you are in this place, to what extent do you feel connected with other people who are in this place?		50	70
Restorativeness	(1) Being away (2) Fascination (3) Extent (4) Compatibility	4	To what extent do you agree or disagree with the following statements?	Likert-type scale from strongly disagree (1) to strongly agree (5).	0.81–0.88 [1] 0.90–0.91 [1] 0.67–0.80 [1] 0.89–0.88 [1]	
Environmental Comfort	(1) Visual (2) Acoustic (3) Thermal (4) Light (5) Global	5	Please tell us your degree of visual/acoustic/thermal/light/place global comfort.	Ordinal 5-point scale: not at all comfortable (1), not very comfortable (2), average (3), fairly comfortable (4), very comfortable (5).	80–100	80–100

Note [1]: These are the Internal consistencies (Cronbach's Alpha) for the four dimensions of the Perceived Restorativeness Scale (PRS) [26].

The calculation of the added variables or dimensions (*Dx*) of these attributes was conducted by applying the following formula, where "*items*" is the variable to be added, "*min*" is the minimum value of that variable, and "*max*" is its maximum value. This formula allowed us to standardise these dimensions on a scale from 0 to 10:

$$Dx = \frac{\sum items - minx10}{max - min}$$

2.4. Procedure

The process followed to carry out the evaluation of the eight places started with the teachers making contact with the three groups of participants (GEO, TEC, and PSY) and concluded with statistical analyses of the data collected from the students' evaluations. Figure 1 shows a flowchart of the process followed, the steps of which are described in more detail below.

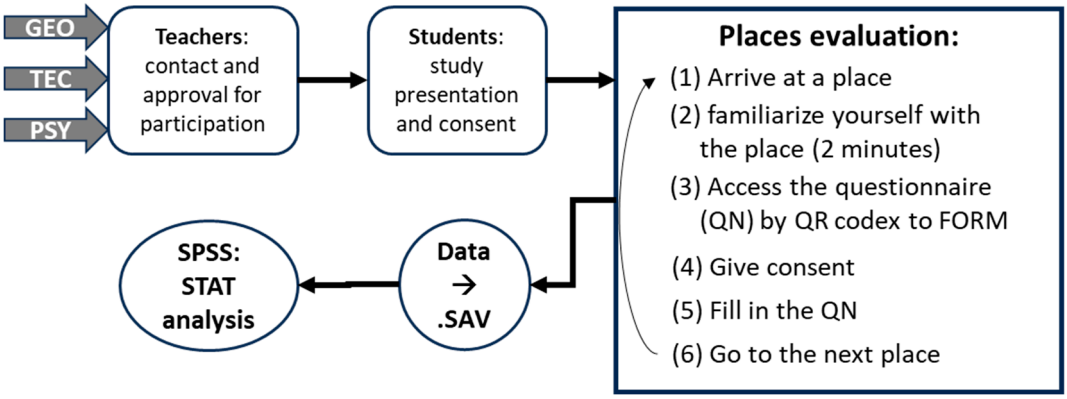

Figure 1. The flowchart of the procedure followed to evaluate the co-benefits of NbSs in this study.

The teachers of the student groups were contacted and asked whether they would be willing to participate in this study. All the teachers were instructed to show the same presentation (a PowerPoint presentation) to their students to explain to them what the procedure was going to be, describe the questionnaire, and show them the places that they were going to evaluate.

Afterwards, each group proceeded to evaluate the previously selected urban places. The GEO group evaluated the places on 16 February 2024, the TEC group on 2 October 2023 and 7 February 2024, and the PSY group over two time periods, one between the 16th and the 25th of 10/2023, and the other between the 10th and 13th of 12/2023. To minimise the differences caused by carrying out evaluations on different dates, the trips were taken on sunny days without precipitation. The climatic conditions were similar (temperature, 15–20 °C; radiation, 200–400 w/m^2; humidity, 70%; precipitation, 0%; and wind, 0–4 m/s).

The PSY students filled in the questionnaire in pairs or threes on the dates they chose within the periods mentioned earlier. They chose randomly in which place to begin and in which to end. On the contrary, the GEO and TEC students filled in the questionnaire guided by their teachers and researchers. Each student group was divided into three subgroups to not saturate the spaces during the evaluation process, and each subgroup made the same itinerary, but starting at different places.

When the students arrived at a place that they had to evaluate, they accessed the questionnaire with their mobile phones using a QR code, and after walking around the place for a couple of minutes, they began answering the questions. The process in each place took about eight minutes.

As this was a non-interventional study, all the participants were informed that their anonymity was guaranteed, as well as why this research was being conducted and how their data would be used. The participants agreed to take part in the study by responding to the questionnaire after having been informed following the procedures established by the laws in force in Spain and the Basque Country regarding the protection of personal data and statistical confidentiality (informed consent).

The statistics software package SPSS (version 24) for Windows was used to encode, store, and process the information gathered. The analysis conducted, as well as the statistical method, will be described in the following section.

2.5. Statistical Analysis

Regarding the description of the results, the median (M) and standard deviation (SD) were used as scale variables, and the frequency (n) and percentage (%) were used as ordinal and nominal variables. Student's *t*-test allowed us to understand the contrast between the means of the two groups, and ANOVA was used in the case of more than two groups. With situations of heteroscedasticity or non-normal distributions, the robust Brown–Forsythe

test was applied. Similarly, regarding the main result variable (co-benefits), effect sizes (Cohen's *d*) were calculated in order to enable comparisons between the groups if the omnibus test turned out statistically significant, providing a solid indicator of the relevance of the difference encountered. Effect sizes higher than 0.70 were considered relevant, and those higher than 1.00 were considered very relevant.

The degree of association between variables was calculated with Pearson's *r*, with effect sizes identified as notorious starting at r > 0.30 (9% of the common variance explained), or as relevant starting at r > 0.40 (16% of the variance explained).

Regression techniques showed the joint effect of contextual variables of the analysed spaces (%Green, %Blue, naturalisation, openness, etc.) on the main variable of this study (co-benefits). In the beginning, a group of indicators were introduced, and each was validated using the model's determination coefficient (R^2), the test of statistical significance (F), the standardised regression coefficient (β), and associated statistical tests (t and *p* values). Afterwards, the participants' characterisation variables were introduced as control variables to evaluate their effect on the indicators. Lastly, with the aim of identifying the contextual indicators that most accurately explained the co-benefits, a stepwise regression model was conducted.

3. Results

This section includes the most remarkable results. First, the results of co-benefit variance analysis are shown, as well as global dimensions according to the places to examine their similarities and differences. Secondly, the relationship between the context factors and the analysed co-benefits is examined. Finally, the results of regression analyses are presented, in which the predicted variable is the global co-benefits, and the explicative variables are related to naturalisation, openness, and so on (the contextual factors). In the second round of analysis, some control sociodemographic variables were added, such as gender and the course studied by the participants.

3.1. Descriptive Results

From Table 5, it can be noted that all the variables (ordinal five-point scale) and dimensions (scale of 0–10) related to the psychosocial co-benefits of NbSs differ significantly depending on the evaluated places. In the range from 1 to 5, out of the thirteen evaluated indicators, nine (62%) are placed above the average value of the range (>3), and four obtained lower values (emotional change, social flow, fascination, and being away, even though the last two are very proximal to the value of 3). Regarding the dimensions, three out of five have an average value higher than 5.22 (in the range from 0 to 10), and two obtained low values (social flow and emotional change, with 3.68 and 3.20, respectively). All comparisons between the locations were statistically significant, although the most relevant effects are shown for visual comfort ($F = 36.075$; $p < 0.001$), light comfort ($F = 30.303$; $p < 0.001$), environmental comfort ($F = 28.993$; $p < 0.001$), and restorative capacity ($F = 27.923$; $p < 0.001$). We can also see some differences in the following dimensions, urban comfort ($F = 35.280$; $p < 0.001$), psychological restoration ($F = 27.688$; $p < 0.001$), and safety ($F = 24.259$; $p < 0.001$), as well as the global dimension of the co-benefits ($F = 28.510$; $p < 0.001$). Taking into account that it is an indicator of the global result of the study, a section of the effects shared between the multiple comparisons of the eight urban spaces was also analysed. Out of the 28 possible comparison combinations, 20 resulted statistically significant, with effect sizes higher than 0.48 and up to 2.59. Out of these 20 comparisons, 15 offered effect sizes higher than 0.70, and of these 15, 11 had an effect size higher than this unit.

Table 5. The results of the variance analysis of the different co-benefits of NbSs and context variables according to the evaluated spaces (N = 437).

	Places										
Variables (Range 1–5)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**	**F**	***p***
Visual comfort	4.48	3.36	3.92	1.86	2.98	3.16	2.79	4.06	3.25	36.075	<0.001
Acoustic comfort	4.43	3.00	3.78	2.61	2.82	3.03	3.04	4.00	3.28	16.327	<0.001
Thermal comfort	3.43	3.42	3.75	2.58	3.21	3.39	3.18	3.82	3.35	9.511	<0.001
Light comfort	4.52	3.22	4.38	2.44	3.93	3.50	2.96	4.39	3.64	30.303	<0.001
Environmental comfort	4.24	3.42	3.93	2.00	3.34	3.42	3.10	4.04	3.39	28.993	<0.001
Fascination	3.67	3.00	3.36	1.74	3.16	2.97	2.58	3.61	2.96	19.279	<0.001
Being away	4.05	3.03	3.31	1.82	3.13	3.16	2.49	3.57	2.99	17.358	<0.001
Coherence	3.57	3.14	3.64	2.11	3.46	3.44	3.12	3.71	3.27	15.206	<0.001
Extent	3.62	2.81	3.65	1.81	3.48	3.11	2.49	4.20	3.13	27.923	<0.001
Day safety	4.62	4.11	4.70	3.47	4.57	4.34	4.25	4.69	4.35	17.737	<0.001
Night safety	2.76	2.25	3.78	2.25	3.61	3.16	2.96	3.73	3.16	19.845	<0.001
Social flow	2.67	2.36	2.78	1.72	2.55	2.45	2.49	2.69	2.47	6.591	<0.001
Emotional change	3.10	2.36	2.42	1.63	2.43	2.32	2.04	2.49	2.28	6.035	<0.001
Dimensions (range 0–10)											
Urban comfort	8.05	5.71	7.38	3.25	5.64	5.75	5.04	7.65	5.95	35.280	<0.001
Restorative capacity	6.82	4.98	6.23	2.17	5.77	5.42	4.18	6.94	5.22	27.688	<0.001
Safety	6.73	5.45	8.09	4.65	7.72	6.88	6.51	8.04	6.89	24.259	<0.001
Social flow	4.17	3.40	4.44	1.80	3.88	3.63	3.73	4.23	3.68	6.591	<0.001
Emotional change	5.24	3.40	3.54	1.58	3.57	3.31	2.61	3.72	3.20	6.035	<0.001
Co-benefits	6.20	4.59	5.94	2.69	5.32	5.00	4.41	6.12	4.99	28.510	<0.001

In general, the places with the highest psychosocial co-benefits correspond to places 1 and 8, which are those with the highest percentages of green surfaces and low percentages of artificial surfaces. Place 1 is also considered a highly naturalised space with a high degree of openness (experts' means of 7.3 and 7.6, respectively). Place 8 is considered the space with the highest degree of openness out of all the analysed spaces.

Place 3 is also associated with good psychosocial benefits, with a high water surface area (8.62%, the second highest after place 2) and a percentage of green surface higher than 50%. It is also considered to have a high degree of openness (experts' mean of 7.3). Moreover, this place, along with place 8, has the highest number of services, with a remarkable amount of commercial activity in its bars and terraces, which enables vibrant social activity in this space.

The places associated with the lowest number of co-benefits are places 4 and 5, which are the ones that have the highest amounts of artificial surface (89.8% and 97.4%, respectively) and the lowest amounts of green surface (10.2% and 2.6%) and branch cover (5.6% and 0.4%). These are also the spaces considered less naturalised by the experts (1.4 and 0.7), and place 4 is also considered the least open space (2.9).

3.2. Correlational Results

Table 6 shows correlations between the five dimensions of the co-benefits and the global dimension with the independent variables of context characterisation. Out of the 54 possible associations between the variables, 42 are statistically significant ($p < 0.05$); 13 present correlations that are higher than 0.30; and 8 present correlations higher than 0.40, which represents commonly shared variance that is higher than 9% and 16%, respectively.

Table 6. Correlations between dimensions of co-benefits (VVDD) and context characteristics (VVII), with mean and SD indicators for each variable (N = 437).

	Urban Comfort	Restorative Capacity	Safety	Social Flow	Emotional Change	Co-Benefits
%Green	0.375 **	0.304 **	0.123 **	0.147 **	0.163 **	0.290 **
%Blue	0.188 **	0.117 *	0.031	0.079	0.062	0.124 **
%Grey	−0.385 **	−0.307 **	−0.122 *	−0.152 **	−0.164 **	−0.294 **
%Trees	0.051	0.024	−0.086	0.057	0.032	0.024
Place services	0.309 **	0.300 **	0.431 **	0.165 **	0.091	0.328 **
Surface (m^2)	0.415 **	0.317 **	0.113 *	0.122 *	0.221 **	0.311 **
Road traffic	0.263 **	0.228 **	0.136 **	0.121 *	0.124 **	0.226 **
Naturalisation	0.278 **	0.214 **	−0.021	0.090	0.152 **	0.190 **
Openness	0.546 **	0.504 **	0.436 **	0.238 **	0.241 **	0.505 **
Mean	50.95	50.22	60.89	30.68	30.20	40.99
SD	20.38	20.59	20.21	20.56	20.74	10.92

* $p < 0.05$ (r > 0.093); ** $p < 0.01$ (r > 0.123).

More specifically, from this table, it can be observed that the different analysed co-benefits are associated with different context characteristics in varied ways, except for the surfaces occupied by tree branches. The co-benefit most associated with the context characteristics is urban comfort, followed by restorative capacity. The closest correlations are found with the openness of space (r > 0.50) and with the surfaces (r = 0.42 and r = 0.32, respectively). There are also significant associations between these two co-benefits and the percentages of green and grey surfaces in opposite ways. The more green and less grey, the greater the urban comfort and psychological restoration.

The co-benefit of security is mostly associated with the openness of the space and with the existing services (r > 0.40). This can also be seen with social flow, but with a more subtle relation (0.24 and 0.17). Emotional change is associated mostly with the openness and surfaces of a place.

The global dimension of psychosocial co-benefits is associated with all the context variables, except for the amount of surface covered by tree branches. The closest relations happen to be with the openness of the space (r = 0.51), followed by the presence of services (r = 0.33), the surfaces (r = 0.31), the green surfaces (r = 0.29), and the percentage of artificial surfaces (it is with negative sign: r = −0.29), and On the other hand, the relationship is more subtle between the percentage of water surfaces and the naturalisation of the place.

3.3. Regression Analysis

With the objective of evaluating the joint effect of contextual variables upon the global indicator of the co-benefits, regression analysis was carried out in two steps. In the first step, the group of contextual variables was introduced, and in the second step, the participants' characterisation variables were added as the control variables of the contextual ones (Table 7). The group of contextual variables introduced in the first step explains 31.7% of the variance in the co-benefits ($R^2 = 0.317$, F = 28.51, $p < 0.001$), with a significative effect shown for openness (β = 0.76, t = 2.05, $p < 0.05$), the amount of surface covered by tree branches (β = 0.59, t = 4.77, $p < 0.01$), and the percentage of blue surface (water) (β = 0.22, t = 2.66, $p < 0.01$). The control variables introduced in the second step did not show any significant effect ($p < 0.05$), incorporating only 0.9% of the variance in the explicative model ($R^2 = 0.009$), without substantially modifying the effects of the three variables identified as significant in the first step.

Table 7. The results of the regression analysis of the context characteristics (first step) and dummy (second step) regarding the global psychosocial co-benefit dimension (N = 437).

	Step 1			**Step 2**		
	Beta	**t**	***p***	**Beta**	**t**	***p***
%Green	0.010	0.024	0.981	−0.024	−0.057	0.954
%Blue	−0.217	−2.662	0.008	−0.199	−2.422	0.016
%Trees	0.592	4.776	0.001	0.615	4.967	<0.001
Place services	−0.069	−0.128	0.898	−0.060	−0.113	0.910
Surface (m^2)	0.155	1.234	0.218	0.198	1.568	0.118
Naturalisation	−0.442	−0.547	0.584	−0.420	−0.522	0.602
Openness	0.764	2.056	0.040	0.734	1.981	0.048
Dummy—female				−0.029	−0.521	0.603
Dummy—TEC				0.118	1.915	0.056
Dummy—GEO				0.022	0.311	0.756
F (*p*)	28.510 (<0.001)			20.687 (<0.001)		
R	0.563			0.572		
ΔR^2	0.317			0.009		

To identify the context variables with the highest relevance in the explanation of co-benefits, a multiple regression stepwise model was used (Table 8).

Table 8. The results of the stepwise regression analysis of the context characteristics (VVII) regarding the global psychosocial co-benefit (VD) dimension (N = 437).

	Beta Stand.	**t**	***p***	**R**	**R^2 Change**	***p* (Change)**
Openness	0.702	11.799	<0.001	0.505	0.255	<0.001
%Trees	0.449	5.364	<0.001	0.532	0.028	<0.001
%Blue	−0.176	−3.218	0.001	0.548	0.018	0.001
Naturalisation	−0.170	−2.315	0.021	0.560	0.013	0.004

The first variable included in the model is openness, which has a positive effect and explain 25.5% of the variance in the co-benefits ($\beta = 0.70$, $t = 11.80$, $p < 0.001$, $R^2 = 0.255$). The second variable, also with a positive sign, is the percentage of trees, which contributes 2.8% to variance ($\beta = 0.45$, $t = 5.36$, $p < 0.001$, $\Delta R^2 = 0.028$). Lastly, in a more marginal way, but still statistically significantly, the variables of the percentage of blue space ($\beta = -0.18$, $t = -3.22$, $p < 0.01$, $\Delta R^2 = 0.018$) and naturalisation ($\beta = -0.17$, $t = -2.31$, $p < 0.05$, $\Delta R^2 = 0.013$) are included in the analysis, with negative values. The final model, with these four factors, turns out to be significant ($F(1;432) = 49.364$; $p < 0.001$) and explains 31.7% of global psychosocial co-benefit variance.

4. Discussion

Before beginning this discussion, it is important to point out two aspects. First, the co-benefits analysed in this study were environmental comfort, psychological restoration (capacity), safety, social flow, and emotional change; that is, this article specifically centres on psychosocial co-benefits, which are mainly associated with human health and wellbeing and the cultural functions of urban ecosystems. The second point is that the selected spaces have shown different characteristics in relation to natural elements (%Green, %Blue, naturalisation, etc.) and in relation to contextual aspects, such as openness, commercial and social activities, and so on.

4.1. NbS-CoBAs Tool Sensitivity

Diving into this discussion, it is worth pointing out that the selection of the spaces evaluated in this article proved to be diverse enough as to show different patterns regarding the co-benefits, which also tells us that the scale potentially has the sensitivity to distinguish places with different context characteristics and their associated co-benefits, as well as those related to the naturalisation (NbSs) of urban spaces.

That being said, the places associated with better psychosocial co-benefits were those spaces with a high percentage of green surface and a high degree of naturalisation (first hypothesis), as well as openness (second hypothesis). The two best evaluated places are urban parks. On the contrary, the places associated with the lowest amount of co-benefits were places with large areas of artificialisation and low degrees of naturalisation (first hypothesis).

These results are in line with the literature on restorative environments and the restorative capacity of natural environments to improve human health and wellbeing [27]. The two main theories on these issues are the Attention Restoration Theory (ART) developed by Kaplan and Kaplan [28] and the Stress Recovery Theory (SRT) postulated by Ulrich et al. [29]. Research on restorative environments has focused primarily on natural settings (outside of urban areas), such as parks and forests [28–30]. Recently studies have analysed these issues and demonstrated that restorative capacity is also possible in urban environments, improving people's cognitive performance, reducing negative effects (tension, anxiety, anger, hostility, fatigue, and stress), and increasing positive emotions such as happiness [31].

4.2. Naturalisation Versus Openness: A Dilemma in Urban Ecosystems

The most relevant context variable for explaining the global psychosocial co-benefits is the openness of space, and not naturalisation, with its variance being 25.5%. The openness factor reminds us of the extension factor, one of the four dimensions of the capacity of the psychological restoration of nature [26,32], which should also be analysed in future studies.

The naturalisation of spaces comes in fourth step in the regression equation, with a negative value after the percentage of surfaces covered by tree branches (second step), which also refers to the naturalisation of spaces, and the surfaces covered by water (third steps, and also with a negative value).

These results are contrary to the third hypothesis, which predicted that the naturalisation of the spaces would contribute more than openness to the psychosocial co-benefits. A possible explanation for these results is that it is not just the naturalisation of urban spaces that is associated with the analysed co-benefits, but also the other context variables. In this study the psychological co-benefits are positively associated with the local services ($r = 0.33$), the surface of the space ($r = 0.31$), and the percentage of the green surfaces ($r = 0.29$) and negatively associated with grey or artificial surfaces ($r = -0.29$), as well as transport traffic ($r = 0.23$), naturalisation ($r = 0.19$) and water surface ($r = 0.12$). Moreover, naturalisation is closely linked to the other context variables related to natural elements, such as %Green ($r = 0.90$), and inversely with %Grey ($r = -0.92$), as well as with %Trees ($r = 0.70$) or the surfaces ($r = 0.68$).

However, these findings are along the same lines as those obtained in other studies. Qiu and Nielsen [33] found that the openness of a space was associated with the experiences of calmness and safety. Interestingly, they concluded that the openness of a space was the factor that allowed the most sensory dimensions to be felt, pointing out the feeling of serenity, which is closely linked to psychological restoration (capacity). These authors [33] also found that safety (which they called refuge) was linked to both the openness of a space and naturalisation, on the one hand because there is no way of hiding in open spaces, and on the

other hand, as a natural space offered a feeling of tranquillity, with noises and movements lessened. Similarly, a study by Sugiyama et al. [34] found evidence that the availability of green or natural environments (naturalisation) was associated with adults' perceptions of better health. They suggested that there was a strong relationship between perceived greenness (naturalisation) and mental health. They also added that restorative effects were likely to occur both during activity in natural environments and from "static" contact with nature, such as viewing natural landscapes. This may suggest that the benefits of naturalisation are those associated with "static" contact with nature, but openness can include both "static" and activity dimensions, which may be the reason why openness is more strongly associated with the psychosocial co-benefits and the psychological restoration capacity.

4.3. Different Co-Benefit Patterns in NbSs in Urban Settings

Another possible explanation for the higher contribution of openness can be found in the fact that the different types of psychosocial co-benefit show different patterns in relation to the context characteristics in urban settings. Therefore, urban environmental comfort and psychological restoration (capacity) are the ones most related to all the analysed context characteristics and most related to openness (second hypothesis). They are also related to some characteristics that show naturalisation, such as the percentage of green surface, and inversely related to the percentage of grey surface (first hypothesis). Safety is associated mostly with the openness of a space (second hypothesis) and with local services that involve some form of social activity (shops, bars, etc.). These urban characteristics allow people to feel more secure. Social flow and emotional change display a minor relationship with the context variables, being non-significant in relation to water surface area or the surfaces covered by tree branches, variables that are related to naturalisation. %Green and %Grey (inversely) have a relation value of r = 0.15 and r = -0.15 respectively with these co-benefits. Emotional change depends mostly on the extension of space (r = 0.22), and social flow depends on the local services (r = 0.17), and both have a close relation with the openness of a space (r = 0.24).

4.4. Limitations and Future Research

This study comprised the first phases of the development of a scale designed to measure the psychosocial co-benefits associated with NbSs, so being at an early stage, it is not free from limitations. One of the main limitations is the use of a sample that did not comprise the real users of the evaluated urban selected places, as well as the fact that it was not a randomly chosen sample. This forced us to avoid the validation of some of the co-benefits on the scale. To resolve these limitations, future studies should apply the scale to the real users of the evaluated urban spaces and compare the results with those obtained in this study.

Another possible limitation is related to the period in which the study was carried out: autumn–winter. It was in this period when students and teachers were available. Although the climate of the study area is temperate, it would be interesting to replicate this study in spring and summer, as it is possible that in these warmer seasons, the perceptions of openness and naturalness will be different.

Due to the relevance of the context variables, the authors believe that in future research, it is necessary for other context variables to be considered or for better quantification to be performed for these variables, especially those related to the social dimension (social relations, place attachment, identity, etc.), as well as climate variables, such as temperature or humidity.

The work presented in this article, which analyses nature's contribution to human health and wellbeing refers to cultural ecosystem services (CESs). These are non-material,

intangible benefits that humans derive from ecosystems, which are indispensable in the wellbeing of communities and directly influence their quality of life according to the Millennium Ecosystem Assessment [35]. CESs include aesthetic inspiration, cultural identity, a sense of home, and spiritual experiences related to the natural environment. These concepts are associated mainly with health and good social relations as constituents of people's wellbeing. In future studies, it would also be interesting to analyse the role of other ecosystem services, such as the regulation of NbSs and their psychosocial co-benefits.

In addition, from the perspective of socio-environmental justice, vulnerable or underrepresented groups (children, elderly people, those on a low income, immigrants, etc.) should be taken into account in order to prioritise them and their living and working environments with this type of urban intervention, which is usually carried out to improve the environments of those who need it the least [36].

5. Conclusions

The most important conclusion that can be extracted from this work turned out, in a way, to be a surprise to the authors, given that it was thought that the variables and factors related to the naturalisation of the spaces would be the ones most related to the psychosocial co-benefits. Even though these variables proved to be important, the results showed that the most relevant aspect was the openness of the space. This result could possibly be explained by the analysed contexts being urban ones, highlighting the necessity of taking into account context variables when analysing psychosocial co-benefits in this type of setting. In the future, it would be interesting to take into account the amount of naturalisation and openness that civilians can access in their day-to-day lives outside these chosen spaces, given the structural characteristics of the areas in which they live.

However, it is important that we explain how the different types of co-benefit show different patterns when they interact with the context characteristics. Higher levels of openness and naturalisation of urban spaces are associated to higher degrees of psychosocial co-benefits, and mainly in relation to environmental comfort and restorativeness.

Taking into account all that has been mentioned, we consider it necessary that we continue working along this line of research, improving the definition of the contextual factors that impact the identified psychosocial co-benefits regarding, on the one hand, the naturalisation of spaces, and on the other hand other factors, such as openness or social activity, which seem to have a relevant role in the co-benefits of urban spaces. An improved evidence-based understanding regarding these concerns is of great importance in developing collective visions to respond to the near-future effects of climate change and to develop adequate and inclusive approaches to adaptation that acknowledge the specific wellbeing needs of diverse populations and social groups beyond the physical and materialistic aspects.

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