DOI: 10.61782/fa.2025.0707

FORUM ACUSTICUM EURONOISE 2025

PROPOSAL FOR A SCALE TO MEASURE PSYCHOSOCIAL CO-BENEFITS OF NATURAL SOUNDSCAPE IN URBAN AREAS

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ABSTRACT

Currently, the integration of Nature-Based Solutions (NbS) in urban regeneration interventions is a trend. They are associated with the improvement of biodiversity in urban spaces. Improving biodiversity also entails the integration of natural sound sources, thus improving the soundscape of these urban environments. NbS are associated with other benefits (co-benefits) such as improving health and well-being, social cohesion, place identity, etc., which corresponds to the field of study of the psychological restorative capacity of nature. The evidence on these psychosocial co-benefits is still limited, and it is also necessary to develop and test assessment tools. This paper presents a psychosocial co-benefit assessment tool. This tool is structured around 13 attributes of psychosocial co-benefits, which refer to two general dimensions: Perceived General Health and Psychosocial Health. The tool has been validated in two phases. The first validation was carried out with experts using the Delphi method, and the second was based on evaluations in real context. The results of these validations indicate that the tool has good validity and is sensitive to differences in the environmental characteristics of urban places. Finally, the applicability of this scale in the specific field of natural sounds is discussed.

Keywords: *soundscape, nature sound, urban areas, restorative capacity, co-benefits assessment.*

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1. INTRODUCTION

1.1 Benefits of NbS in the urban settings

In recent years, the inclusion of Nature-Based Solutions (NbS) interventions has increased to address the major challenges facing our society, related to climate change and environmental pollution-Zero Pollution- [1].

Many of these interventions focus on the urban environment, such as schoolyards, regeneration of historic city centres, amenity areas or degraded industrial areas. They aim to improve the urban environments in which they are located due to the current trend of global urbanisation [2]. This trend also extends into the future, as cities are expected to continue growing, especially in developing countries. The overcrowding of cities is usually associated with environmental and health problems.

Furthermore, limited space availability in the built environment, urban demographic changes, and cultural diversity also contribute to increasing social and urban vulnerability, exacerbating inequalities [3].

The use of NbS in urban regeneration processes, such as those discussed above, has proven to be a multifunctional solution that brings positive impacts (benefits) on biodiversity, climate mitigation and resilience, environmental quality (including water), water management and natural and climate risks, microclimate regulation and air quality [4-5], as well as on economic activity in the area of influence of the intervention, such as new job opportunities, green jobs... [6].

1.2 Co-benefits of the contact with nature

In addition to the benefits of improving the physical and economic conditions of the environment outlined in the previous section, NbS are associated with other less

tangible benefits, such as improved health and bio-psycho-social well-being of individuals and communities [7].
These are often referred to as co-benefits, because they are benefits that were not initially thought to exist. Most of these co-benefits are psychosocial in nature, i.e. they depend on people's perception and valuation of both the NbS and other contextual aspects of the intervention. Some of these psychosocial co-benefits are social cohesion, social identity, environmental comfort (including acoustic comfort), (socio)environmental justice (equity, inclusiveness, social diversity...), emotional change... [8-10].
This line of research places us in the field of the restorative capacity of nature, which focus on the study of the characteristics of environments that facilitate psychological restoration, thus contributing to human health and well-being [11]. In early studies, the restorative experience was only associated with natural environments, but in recent years it has been shown that psychological restoration can also occur in urban environments with natural elements, such as parks and urban squares [12-13]. Users of these urban environments showed improved cognitive performance and a reduction in negative affect variables (tension-anxiety, anger-hostility, fatigue and stress), in addition to reporting increased happiness or positive emotions [14-15].
While there is an abundant literature on the environmental benefits of NbS and their measurement methodology, when focusing on psychological well-being and social benefits (psychosocial co-benefits), the evidence is limited, with significant gaps on how to measure or evaluate them [16].
This is why in the Horizon Europe program the study of the impact of natural elements on health, well-being and social cohesion is considered a priority area. Also, health and well-being professionals recommend interdisciplinary and cross-sectoral actions to enable the provision of - and access to - blue and green elements to address urban challenges and contribute to social cohesion [6].
To contribute to the understanding of the psychosocial co-benefits of NbS, it is necessary to develop and test assessment tools that contribute to a common framework of its benefits on health and bio-psycho-social well-being. Understanding a person's well-being requires measuring cognitive and affective responses, as well as psychosocial issues such as social interaction and cohesion, or sense of belonging [17]. And the most appropriate method to measure these co-benefits is psychosocial research/studies.
Based on the above considerations, a tool was initially designed to measure the co-benefits of NbS. However, the authors consider it can also be applied to measure the psychosocial co-benefits of natural soundscape in urban environment, as these are a direct of biodiversity enhancement through NbS in urban environments. Therefore, this proposal is presented here.

2. METHODOLOGY

2.1 Proposal of tool to assess the Psychosocial Co-Benefits of NbS

The tool to assess the Psychosocial Co-Benefits of NbS (in short NbS-CoBAs tool) was initially developed in the framework of the H2020 project CLEVER-Cities (clevercities.eu) through a participatory and co-design process. The process of building the scale is presented in Figure 1.

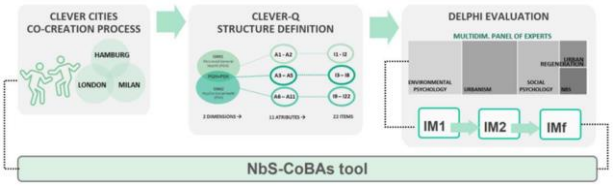

Figure 1. Co-creation process of development and validation of the NbS-Co-BAs tool [16].

The NbS-CoBAs tool contains 24 items that are structured around 13 psychosocial co-benefits, which are grouped into two global dimensions (see Figure 2):

- **Perceived General Health:** The attributes in this group are perceived general health and physical activity facilitation capacity.
- **Psychosocial Health**: Attributes about sense of belonging, socio-environmental justice, social cohesion, participation, perceived safety, capacity to generate changes in emotional state, and social flow.
- **Perceived General Health and Psychosocial Health**: The attributes that relate to the two general dimensions are the followings: subjective wellbeing, restorativeness (4 subdimensions), place satisfaction, and environmental comfort (4+1 dimensions).

Most of these co-benefits are measured by 1 or 2 items except urban comfort and restorativeness.
Environmental comfort refers to the general environmental comfort of the place users, as well as the specific comfort in relation to visual, acoustic, thermal, and light components.
Restorativeness is evaluated by four dimensions [18]: (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.

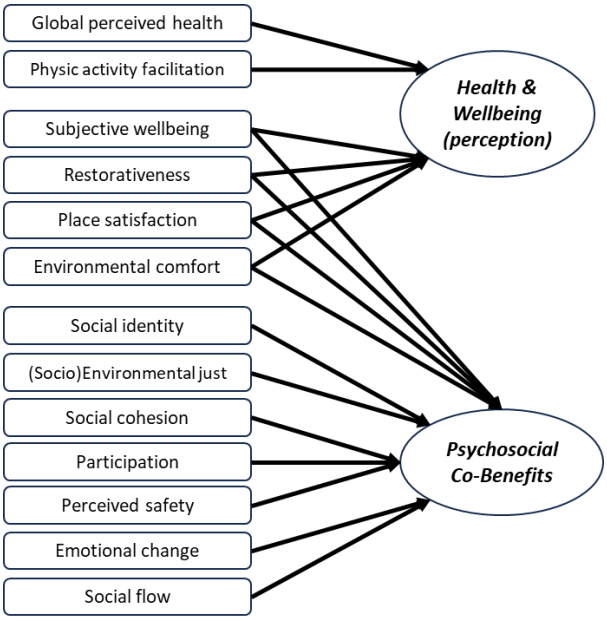

Figure 2. Dimensional structure of the NbS-CoBAs tool.

To facilitate the participants' responses, the questions (items) were grouped into the same response format and thematic groups of questions. The most used response scale types were the (Dis)Agree scale ("How much you/In what extent do you agree or disagree with following statements?") whose answers can be collected using an ordinal scale of 5 points ("strongly disagree", "disagree", "neither agree nor disagree/undecided", "agree", "strongly agree"). This response scale was used with the following co-benefits: restorative capacity or psychological restorativeness, environmental justice, social cohesion and social participation.

Another 5-point ordinal scale (not at all, a little, moderately, quite a lot, and a lot/very) was also used for environmental comfort, security of place and identity, social flow and emotional change, life satisfaction.

The added variables or dimensions of these attributes was standardized on a scale from 0 to 10:

3. RESULTS

The results presented in this section refer to the validation of the tool, which was carried out in two phases. The first one, based on an expert panel using Delphi method, face and content validity was analysed. The second validation was based on user evaluations in real-world settings, which analyzed the tool's sensitivity to differentiating between urban environments that differed in terms of naturalization and openness.

3.1 First validation with expert's panel

The Delphi method was used to assess the face and content validity of the NbS-CoBAs tool, in which a multidisciplinary panel of experts participated.

The Delphi method deals with a systematic and interactive evaluation process in which a panel of independent experts provides anonymous opinions and feedback. It is a flexible method that serves to enrich consensus. In the method, the judgments are summarized and sent again to refine the problem in a varied range of fields [19].

Following the sequence of the Delphi method, a panel of 13 professional experts in the fields of environmental (4) and social psychology (3), urbanism (4), urban regeneration (1), and Biology (1) was formed. In the first and second rounds, 10 experts participated. In this study, experts are those individuals with more than 10 years of experience working on the related fields. Indeed, most of the participants have over 20 years of experience, and in some cases, even 40.

The first version of the matrix instrument consisted of 22 items referring to 11 attributes grouped around two general dimensions. In the final version, two new items referring to two new co-benefits were included: *social flow* and *emotional change*.

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%). These results indicate that it has good face and content validity, concluding with the potential applicability of this tool in different contexts.

3.2 Second validation with users

In this second stage the tool was validated in real spaces with a sample of users, who evaluated a set of eight urban spaces with different levels of naturalisation and openness.

The second validation was developed in the framework of the UK2050 LIFE project. (www.urbanklima2050.eu).
In this validation [20] there was a sample of 115 participants, balanced regarding the gender (51.1% women), who made a total of 437 valid evaluations.
The participants were students in the final year of a course in Geography, Urban Design, or Psychology. Their average age was 21.51 years (SD = 4.89), and 80% were between 19 and 22 years old.
The eight selected places were localised in a single neighborhood in a coastal Cantabrian city (Spain). The selected places were very close to each other, suggesting that similar sociodemographic and sociocultural variables would affect the evaluation of these locations.
To evaluate the tool sensitivity to the presence of natural elements in urban surroundings, these places were selected because they have different degrees of naturalisation and openness. Out of these eight places, three are urban parks, two are wide and open squares, and the rest are small traffic-free squares, delimited by tall buildings.
The results of this second validation 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.

3.3 Relation acoustic comfort with natural features of the urban context

In the NbS-CoBAs tool , the acoustic comfort is an attribute of the environmental (urban) comfort dimension In the second validation of the tool, acoustic comfort is closely related with urban comfort ($r=0,81$; $p<0,001$) and psychological restorativeness ($r=0,58$; $p<0,001$) dimensions, as well as the global dimension of psychosocial co-benefits ($r=0,62$; $p<0,001$). In other words, acoustic comfort is a relevant part of the psychosocial co-benefits of being in contact with natural elements in the urban environment.
Urban comfort, which includes acoustic comfort, is the dimension of psychosocial co-benefits most associated with contextual variables related to naturalization and openness of urban settings. And acoustic comfort is significantly ($p<0,001$) associated with openness ($r=0,37$), surface ($r=0,37$), percentage of green ($r=-0,30$), percentage of artificial surface ($r=0,30$) and naturalization ($r=0,22$), as well as place services ($r=0,20$).

4. CONCLUSION & DISCUSSION

Several conclusions can be drawn from this work:

- In relation to the *psychometric properties* of the scale, the results indicate that the scale and its components have *good face and content validity*, as well as *good reliability*.
- NbS-CoBAs scale has also been shown to be *sensitive* to differences in the *naturalness* and *openness* of urban spaces. Therefore, we can conclude that the scale has good psychometric properties and can be applied to assess the psychosocial co-benefits of natural elements, including soundscape.
- The scale, which was initially defined for the evaluation of the co-benefits associated with the NbS, can also be applied to measure the psychosocial co-benefits of *natural soundscapes*, because these are one of the aspects associated with the improvement of biodiversity, which is a direct benefit of the use of NbS in the urban environment.
- When focusing on natural soundscapes, *environmental acoustic comfort* would be one of the most closely related psychosocial co-benefits, so it is considered necessary to improve the measure of this co-benefit. For this, it is proposed, following the recommendations of ISO/TS 12913-3, to use one of the semantic differential scales based on the circumplex model of SSC attributes, as is the case with the ACAS-12 tool developed to evaluate acoustic comfort and which reflects the affective dimensions of SSC attributes [21]. In order to contribute to improving the evidence in this regard, it would be necessary to validate this new version of the scale in urban environments with different types of sounds (technological, social, natural), comparing the results.
- The results indicate that acoustic comfort is closely associated with global environmental comfort ($r=0.81$). Also, the relationships are strong with the aggregate dimension of all psychosocial co-benefits ($r=0.62$), psychological restoration ($r=0.58$) and, to a lesser extent, with social flow ($r=0.36$), security ($r=0.34$) and emotional change ($r=0.31$).
- The authors believe that the NbS-CoBAs tool could be applied to additional contextual variables within interventions aimed at enhancing the urban environment. Such improvements may contribute to the advancement of urban public spaces and their functions, encompassing social aspects (relationships and cohesion), identity (sense of belonging), and health (bio-

psycho-social and emotional well-being), with particular emphasis on mitigating stress associated with daily life.

- The incorporation of NbS within quiet areas offers significant benefits in mitigating global annoyance and the adverse health effects associated with environmental noise. By integrating natural elements such as green spaces, water features, and vegetation, NbS can create calm environments that reduce the perception of noise pollution and its impact on residents. These quiet areas not only provide a respite from the constant hum of urban life but also promote mental and emotional well-being by offering serene spaces for relaxation and reflection as well as the reduction of stress and improvement of the perception of global health. This approach underscores the importance of designing urban spaces that prioritize the health and comfort of inhabitants, ultimately contributing to more livable and sustainable cities.
- The authors identify two co-benefits that require further definition and enhancement: social flow and emotional change. These co-benefits were integrated into the latest version following the initial validation by the panel of experts.
- Additionally, it would be beneficial to validate the scale through pre- and post-intervention evaluations to refine the methodology for measuring the co-benefits of various environmental attributes on the psychosocial health of urban populations. It is important to note that, according to the World Bank, the urban population in 2023 was 57% globally, 73% in Europe, and 82% in Spain.

5. ACKNOWLEDGMENTS

This research was developed within the framework of two European projects: Urban Klima 2050 (LIFE 18 IPC 000001), and CLEVER-Cities project (Horizon 2020 ID 776604). The authors would also like to thank the teams of experts, teachers and students who participated in these studies for their dedication, time and effort.

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