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**Assessing Urban Social justice and equality in Turin through
Nature-based Solutions: Insights from the GREEN-INC
Project**

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List of Abbreviations

NBS - Nature-Based Solutions
ICAs - Inclusive Climate Actions
EC - European Commission
EU - European Union
KPI - Key Performance Indicator
IUCN – International Union for Conservation of Nature
UF - Urban Forestry
GI, BI – Green and Blue Infrastructure
ESS - Ecosystem Services
EBA - Ecosystem-Based Adaptation
Eco-DRR - Ecosystem-Based Disaster Risk Reduction
GBI - Green-Blue Infrastructure
LID - Low-Impact Development
BMPs - Best Management Practices
WSUD - Water-Sensitive Urban Design
SUDS - Sustainable Urban Drainage Systems
EE - Ecological Engineering
SIA – Social Impact Assessment
LCA – Life Cycle Assessment
SA – Stakeholder Analysis
SROI - Social Return on Investment

Abstract

This thesis explores the intersection of social justice and environmental sustainability by evaluating how Nature-Based Solutions (NbS) contribute to equity in urban contexts. Rooted in the GREEN-INC European project, funded under the Driving Urban Transitions (DUT) initiative, the research focuses on the city of Turin as a case study. While NbS are widely recognized for their environmental benefits, recent studies suggest that, if not intentionally designed to be inclusive, they can exacerbate existing socio-economic inequalities. This study responds to that concern by assessing and evaluating the impact of implemented NbS whether their benefits are equitably experienced by diverse population groups in Turin city,

the research employs a survey-based methodology to assess six social indicators derived from the broader framework proposed in the article "*A place-based framework for assessing the effectiveness of inclusive climate actions for nature-based solutions in cities*" by Virginia Pellerey and Sara Torabi Moghadam.

The selected indicators three core- *Citizen Involvement in Environmental Education, Estimated Morbidity and Mortality, Proportion of Citizens Involved in Participatory Processes* - and three supporting indicators - *Perceived Quality of urban spaces, Proportion of Community who Volunteer and Engaged with Projects, Bridging and Bonding*, - form the foundation of the assessment framework.

The specific contribution of this thesis to the GREEN-INC project lies in the development and use of a methodology for assessing these six social indicators through specifically designed, bilingual (Italian-English) questionnaires completed by city dwellers of Turin. The data thus collected was processed using Python within the Google Colab environment to compare and analyze the perceptions, degrees of participation, and perceived effects of NbS intervention. This work is underpinned by a review of the literature and in-depth analysis of Turin-based case studies of NbS: City Water Circle, Orti Generali, ProGIreg Green Walls and Valdocco Vivibile.

Research findings indicate that if NbS are implemented in a manner that considers the local context and involved the local community, then they have the potential to generate enhanced awareness, social participation, and perceived social value among residents. The study concludes that the integration of principles of social equity into planning for NbS maximizes environmental resilience and equitable development in cities. The findings generated offer actionable guidelines to policymakers, researchers, and urban planners on how to embed equity-based evaluation frameworks in future NbS strategy.

Keywords: Nature-based solution, Impact evaluation, Effectiveness, Justice, Equality, KPIs, European commission, Turin.

Chapter 1

1. Introduction

The term Nature-based Solutions (NbS) has emerged prominently over recent times among both urban planners and scholars. The European Commission (2015) has defined NBS as approaches that are guided by, and drawing support from, natural processes, aimed at solving environmental, social, and economic issues sustainably (European Commission, 2015).

The growing climate crises need an urgency with which city leaders may respond to innovating disruptive solutions to attenuate the environmental threats and, at the same time, deal with the embedded social inequalities. Nature-based Solutions (NbS) offer a hopeful way to finally use nature's healing powers to strengthen urban resilience. Nature-based Solutions (NbS) can often increase urban inequality if they are not paired with inclusive urban planning and environmental management (European Commission, 2021). Nature-based solutions (NbS) are effective, nature-inspired strategies that leverage natural processes to deliver environmental, social, and economic advantages. These cost-efficient approaches enhance climate resilience by incorporating natural elements into urban and landscape planning (European Commission, 2015).

While NbS have many advantages, they can unintentionally deepen urban inequalities and injustices. For instance, NbS in wealthy areas might increase real estate value and eventually drive out low-income residents; this has been called green gentrification (Anguelovski et al., 2018). In this regard, ICAs have been proposed as a way to avoid these pitfalls. ICAs are strategies oriented towards climate action and social equity, entailing that the benefits of NbS will be equitably shared between socio-economic groups.

New research underscores that effective implementation of nature-based solutions (NbS) calls for more than ecological planning; it requires inclusive governance that is both equitable and inclusive. Wamsler et al. (2020) demonstrate that the incorporation of NbS in planning within the city is closely linked to Inclusive Climate Actions (ICAs), for both emphasize collaborative, equitable, adaptive strategies for attaining resilience to climate change. They outline strategic engagement with residents, cross-sector cooperation, and institutional transformation from within among core strategies that are aligned with the intrinsic ICAs' principle. These relational and participatory strategies are pivotal not only to overcome institutional and legislative barriers but also to include NbS in long-term planning. ICAs therefore provide the social foundation for enabling and sustaining NbS to render attempts to adapt to climate change environmentally effective and equitable.

This work is conducted under the umbrella of the GREEN-INC project (GRowing Effective & Equitable Nature-based solutions through INCLUSIVE Climate actions), funded by the Driving Urban Transitions (DUT) partnership under the European Union. DUT enables financial support to cities to create innovative solutions for urban climate resilience, social inclusion, and sustainability. In this context, GREEN-INC aims to co-design and assess Nature-based Solutions (NbS) that are environmentally effective and equitable, specifically through the incorporation of

Inclusive Climate Actions (ICAs). The ICAs framework focuses on participatory, equitable, and context-conscious strategies for climate adaptation by making climate benefits and burdens equitably distributed among urban dwellers (GREEN-INC, 2025).

The GREEN-INC project, which engages five European cities: Amsterdam, Brussels, Bucharest, Skellefteå, and Turin, and six institutional and academic partners, adopts a multi-level framework for assessing environmental, economic, and social effects to evaluate the impacts of NbS when delivered as an ICA. The framework for evaluating impacts encompasses both standard Core KPIs, which can be universally used for different urban contexts, and accompanying place-specific indicators for each city, depending on its unique requirements and challenges (Verbeiren & Verstraeten, 2024).

This dissertation is specifically based on the city of Turin, one of the pilot cities for the GREEN-INC program. Although the overall GREEN-INC program is centered on ICAs, this work specifically deals with evaluating the impact of implemented Nature-based Solutions (NbS) in addressing social injustice and reducing urban inequality.

The six social indicators used for carrying out such the assessment of this thesis are: - *Bridging and Bonding*, *Estimated Morbidity and Mortality*, *citizen involvement in environmental education*, *perceived quality of urban spaces*, *Proportion of Citizens involved in participatory processes*, *Proportion of Community who Volunteer and Engaged with Projects* - These are based on Pellerey and Torabi Moghadam's (2025) framework in "A Place-based Framework for Assessing the Effectiveness of Inclusive Climate Actions for Nature-based Solutions in Cities." The framework allows a systematic assessment of NbS effectiveness by blending a minimal set of generic KPIs with context-specific indicators chosen by participatory means. The process of choosing the indicators is based on a sound methodology that involves a systematic PRISMA-based literature review, Pareto analysis and compatibility tests to refine them, and a Fuzzy Delphi method-based final ranking, complemented by stakeholder consultation.

To contextualize this assessment, the thesis examines four case studies in Turin:

- the City Water Circle project
- Orti Generali
- ProGIreg Green Walls
- Valdocco Vivibile

These four case studies provide the empirical foundation for understanding the ways in which varying types of NbS interventions can impact facets of social equity and justice, ranging from public health through to civic participation and perceived urban quality.

By situating this research within the context of Turin and basing it on only these six indicators, this dissertation makes an empirical and context-specific contribution to evaluating the social indicators of NbS. The research and its outcomes target urban planners, and researchers, and intend to assist them in creating NbS that are socially responsive, and environmentally responsible to mitigate inequalities in participation, and benefits distribution during urban green transitions.

1.1. Problem Statement

Urban environments today face the dual challenge of increasing climate vulnerability and deepening social inequality and injustice. Nature-based solutions (NbS) have been presented and offered as the most promising arena to meet the above-mentioned challenges through the exploitation of natural processes for the improvement of urban resilience. Most of the deployments of NbS, however, may be perpetuating, in an inadvertent way, the prevailing urban inequity and therefore not necessarily benefiting equitably all social segments of the population. This reflects badly on the fact that social justice has not been integrated into the process of planning the projects and implementation at large (Kabisch et al., 2016).

The GREEN-INC European project focuses on exploring the efficacy of Inclusive Climate Actions (ICAs) concerning the inclusion of NbS in urban environments with regards to mitigating social inequalities. It addresses directly a crucial deficiency in systematic review research on ICAs, that of the nexus between resilience and social equity. It is a deficiency that is most explicitly evident in cities like that of Turin, where diversity of social backgrounds and the differential degrees of susceptibility to climate impacts commingle and create intricate challenges (GREEN-INC, n.d.).

Furthermore, although NbS are recognized for their potential to mitigate climate effects and enhance urban quality of life, there is a lack of robust methodologies specifically designed to assess social impacts, which hinders our ability to evaluate their contributions to social justice.

The following paragraphs introduce the two main problems identified from the existing literature and addressed in this thesis.

Problem one, Planning gap: Despite increased urban planning uptake of Nature-based Solutions (NbS), social justice is not taken into consideration in the development and implementation of the projects. The majority of the projects rely more on the performance of the environment and technical advantages as opposed to distribution of clean air, vegetation cover, and climate protection. This has unequal outcomes that advantage the privileged but disadvantage and displace marginalized groups.

Anguelovski and Corbera (2022) warn that if not specifically combined with social inclusion, NbS have the risk of being used as "nature-enabled dispossession" tools that augment rather than dissolve socio-spatial inequalities. Bauer (2023) adds that NbS pose a risk of deepening "green capitalism" unless they are rooted in procedural, recognition, and distributional justice.

All of this is most visibly apparent in the Global South, where participation is typically tokenistic but not authentic co-creation. According to Lakshmisha et al. (2024), projects generally miss symbolic participation and raise questions around who stands to gain truly and who makes the decisions. In these contexts, NbS have the potential to deepen existing injustices unless equity and inclusion become a core concern of their development.

Problem two, Evaluation gap: existing assessments tend to majorly focus on indicators that are highly related to the physical environment, hence ignoring important signals that reflect larger social implications. (Freitas, Rodrigues, & Santana, 2020). Such assessments are likely to lead to interventions that actually neither address nor recognize the intended socio-economic disparities to be mitigated. (Frantzeskaki et al., 2019).

Despite the growing recognition of the multifunctional nature of Nature-based Solutions (NbS), the evaluations conducted hitherto focus mainly on the environment's ecological performance and resilience towards climate changes, with less emphasis put on the social outcomes. The studies exhibit a critical imbalance when appraising sustainability factors with the environment outpacing the social and economic factors to a very high degree. For instance, Dumitru et al. (2020, as quoted in Assumma et al., 2023) observed that regarding approximately 60% of the papers reviewed, they concerned themselves with the environment, with only 30% of them taking into account the social and health factors.

The one-sided emphasis is an extension of an overall conceptual and empirical value assessment imbalance, where principal social values of equity, social cohesion, and well-being are frequently held as subsidiary or are left unaccounted for. Hence, there is difficulty identifying how and if NbS promote social justice and inclusive urban resilience. Furthermore, inasmuch as there is some focus on distributional justice in the sense of access to green infrastructure on an equitable basis, procedural and recognitional forms of justice tend not to find a place within evaluation designs (Snep et al., 2023)

This study bridges that gap by suggesting and using a method - focusing on six selected social indicators - to evaluate the equity-related effects of four Turin NbS case studies. It aims at enhancing the capacity for monitoring social outcomes at the local level, supporting more inclusive planning, and ensuring that implementation of NbS is consistent with wider urban justice and inclusion aims.

1.2. Research Question

How can the social impacts of Nature-Based Solutions (NbS) in Turin be evaluated using a set of inclusive, equity-oriented indicators to ensure they address urban inequalities and promote social justice?

1.3. Research Objectives

The research objectives of this thesis are illustrated in (Fig. 1) These include:

- Proposing Assessment Method of the six Social indicators from “A place-based framework for assessing the effectiveness of inclusive climate actions for nature-based solutions in cities” article (Pellerey & Torabi Moghadam, 2025).
- Evaluation of Social Indicators: Based on the indicator assessment template developed by the GREEN-INC project, a comprehensive questionnaire was designed around six social indicators. It was distributed through diverse channels to ensure broad participation and the collection of reliable data.
- Analyzing the Turin Social Indicator Data: To evaluate these data from these six social indicators, using Python code within the Google Colab.

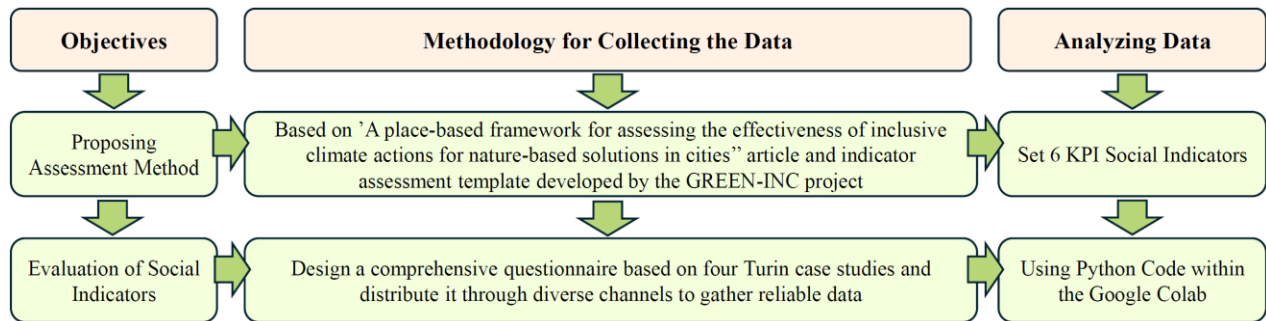


Figure 1: Flowchart of Thesis Objectives

1.4. Thesis Structure

The thesis is structured into seven chapters as illustrated in (Fig. 2), each containing valuable information relevant to addressing the research question.



Figure 2: Flowchart of Thesis Structure

This thesis starts with an introductory part providing a general idea of Nature-based Solutions (NbS) as solutions that apply natural processes as a means of solving social problems, and is structured into four sections: the problem statement, the GREEN-INC European Project, the research question and the objectives of the research. The following chapters consist of a review of the literature into NbS and concerned social issues, a methodology on the methods of using surveys and spatial analysis, four case studies of the City of Turin, an analysis of the most significant social implications, a conclusion on NbS and social justice, and a bibliography in APA format.

Chapter 2

2. Literature Review

The literature review has been conducted meticulously and is structured into three main sections as shown in (Fig. 3) to make sure that the topic is fully exhausted and understood.

The first part is a detail-oriented review of scholarly articles relevant to the definition and concept of nature-based solutions,.

The second part focuses on existing literature concerning Social Impact Assessment (SIA).

The third part is combination of these two sections will provide a theoretical as well as practical dimension to the subject, which may help circumvent prevalent pitfalls and provide nuanced understanding for research in that field.

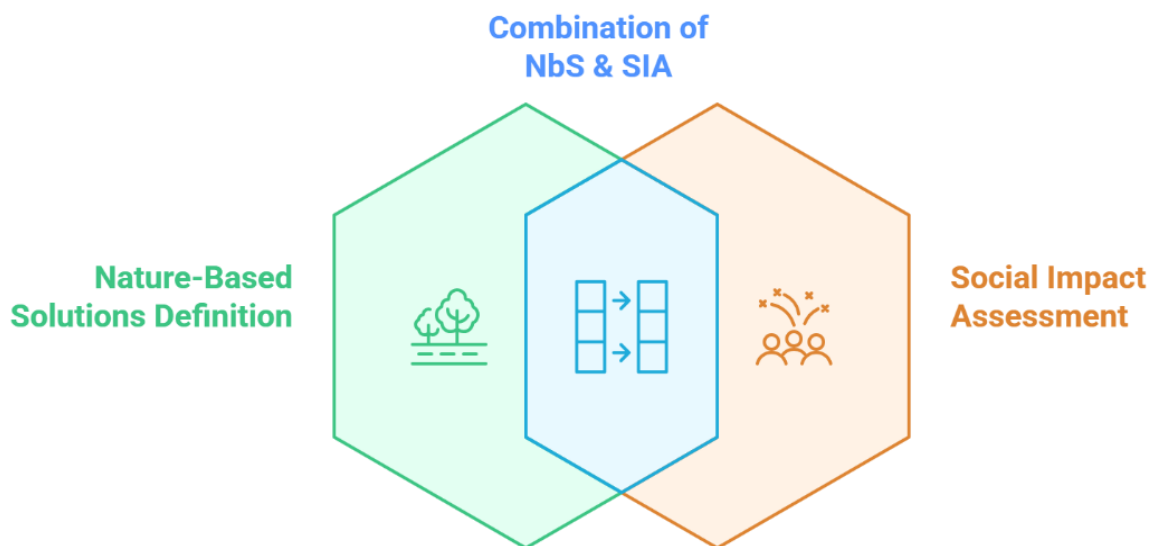


Figure 3: Flowchart of Literature Review

2.1. Nature-Based Solutions Definition and Concept

The Nature-Based Solutions have been gaining ever-increasing ground as holistic, dynamic remedies to the environmental, social, and economic challenges. With numerous definitions developed by institutions and scholars, they, though varying in focus, agree on the overall concept of capitalizing on natural processes to boost sustainability.

The European Commission (2015) characterizes NbS as "solutions inspired and informed by nature, that are cost-effective, that deliver environmental, social and economic benefits at the same time and promote resilience." It highlights multifunctionality, explaining that NbS promote resource efficiency and ecosystem quality in urban, rural, and coastal areas by means of context-specific and holistic solutions. On that basis, the European Commission (2021) also highlights that

NbS are to be coupled with inclusive planning and that, in the absence of that, NbS could aggravate social inequalities.

Likewise, the International Union for Conservation of Nature or IUCN, in 2016, has defined NbS as "actions to protect, manage sustainably, and restore natural or modified ecosystems that are effective and adaptive in solving society's challenges and also deliver human well-being and biodiversity benefits." The focus here is on ecosystem integrity and human-oriented results.

Parallel to institutional perspectives are definitions that exhibit diverse disciplinary focus by scholars. Maes and Jacobs (2015) define NbS as "any transition toward a dependence on ecosystem services with a reduced input of non-renewable natural capital and greater investment in renewable natural activity," highlighting economic transformation to sustainability and natural resource efficiency.

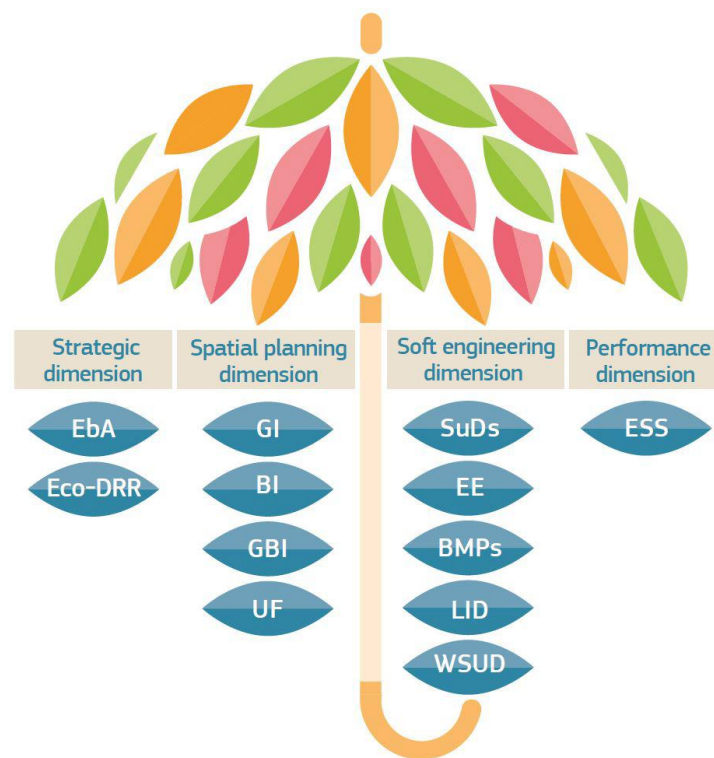


Figure 4: NbS are an umbrella concept and encompass a number of existing concepts and practices
(Source: (European Commission, 2021))

Kabisch et al. (2016) concentrate on biodiversity and define NbS as measures to maintain, enhance, and restore nature to tackle multiple societal and ecosystem challenges. Their definition highlights the co-dependency of ecological health and human well-being.

Dorst et al. (2019) characterize NbS as natural process-based interventions explicitly focused on resolving urban sustainability issues, including flood hazards, heat stress, and urban ecological degradation. The practical definition highlights NbS as concentrated evidence-informed measures targeting the immediate issues of cities.

A social-political undercurrent is found with Frantzeskaki et al. (2017), who frame NbS as transformative, actor network-based processes. Not only are NbS ecological interventions, but they argue, they are socially grounded strategies co-produced within actor networks. With this, NbS have the potential to become instruments for constructing new urban commons and communicative modes of governance.

A Nature editorial in 2017 emphasizes the multidisciplinary and urgent character of NbS, highlighting the need to mobilize cross-sectoral and evidence-based solutions to confront global challenges to habitat loss and climate change adaptation.

According to van den Bosch and Sang (2017), NbS serve as a umbrella concept that is shown in (Fig. 4) synthesizes and builds upon current frameworks like green infrastructure, ecosystem services, and ecological engineering. Indeed, the range of NbS practices varies from urban forestry (UF), green-blue infrastructure (GBI), ecosystem-based adaptation (EbA), sustainable urban drainage systems (SuDS), low-impact development (LID), and ecosystem-based disaster risk reduction (Eco-DRR) (European Commission, 2021). These measures share the same overall aim of supporting sustainable and resilient city development.

In short, definitions of NbS range within disciplines and institutions, but common guiding principles are: reliance on natural systems, seeking co-benefits produced (environmental, social, economic), local context adaptation, and transformative potential. Convergence of definitions emphasizes NbS integration with city and regional planning with participatory, multidisciplinary, and context-dependent practices.

2.1.1. Overview and Analysis of Key Articles on Nature-Based Solutions

Nature-Based Solutions (NbS) are being increasingly recognized as effective means for solving complex environmental and social problems through natural processes. (Table.1) presents major studies analyzing different facets of NbS, ranging from conceptual definitions to frameworks for appraisal, implementation strategies, and public perceptions.

The research methodologies used throughout these studies are diverse, consistent with the interdisciplinary focus of NbS research. Of the papers examined, systematic literature reviews feature most strongly, appearing within four different studies (Dorst et al., 2019; Zhu et al., 2023; Istrate & Hamel, 2023; Tedesco et al., 2022). Conceptual analyses integrated with expert workshop studies also feature, for example, Eggermont et al. (2015) and Kabisch et al. (2016), emphasizing attempts at establishing solid typologies and frameworks for NbS.

Other methods involve quantitative methods such as Multi-Criteria Decision Analysis (MCDA), as seen through the work of Caroppi et al. (2024), based on utilizing Key Performance Indicators (KPIs) while monitoring performance. Empirical processes, involving spatial analysis and statistical modeling, are seen from research work undertaken by Richards et al. (2022), who examined ecosystem services for the world's largest cities, and Anguelovski et al. (2018), who worked on performing spatial analysis for examining green gentrification patterns within Barcelona.

In study scales, urban contexts prevail, encompassing five studies specifically set within urban contexts (e.g., Giachino et al., 2021; Richards et al., 2022; Anguelovski et al., 2018). Nonetheless, the global study scale is also well-represented, with three studies comparatively studying at a larger scale (Sowińska-Świerkosz & García, 2022; Schaubroeck, 2018; Richards et al., 2022). Rural and national contexts are underrepresented, each being the subject of one study, and thus, we advocate for geographic diversity within study scales for NbS studies.

A common necessity found among these papers is the understanding that numerous factors for the success and implementation of NbS are vital, including coordination of them with existing policy and stakeholder involvement. For instance, Kabisch et al. (2016), Frantzeskaki et al. (2019), and Dorst et al. (2019) pose the necessity for the compatibility of the NbS with the policy framework and the involvement of multiple stakeholders for long-term sustainability for their practice. Subsequently, Caroppi et al. (2024), Zhu et al. (2023), and Eggermont et al. (2015) cite the immediate demand for more concise as well as consistent definitions and the implementation using standard evaluating and measurement criteria. Overall, the articles cite the use of operational tools and standardization to make it more applicable and effectively implementable within urban spaces that have varying settings.

Giachino et al. (2021) explore the capacity of Nature-Based Solutions (NBS) for the mobilization of younger cohorts - i.e., Generation Y (Millennials) and Generation Z in the context of sustainable urbanization and tourism. Characterized by the European Commission (2015) as being “inspired by, supported by or copied from nature” and solving societal problems as well as yielding multiple co-benefits, NBS constitute solutions like green roofs, riverbank revegetation, and the urban conversion of brownfields into green public spaces. Based on the increased awareness of sustainability among younger groups, the research suggests that effectively communicated and accessible NBS might boost urban tourism value by appealing to the green worldview of youth.

The authors selected a sound quantitative research method to measure awareness, perception, and tourism behavior towards NBS among the students in Turin, Italy. The data were gathered using an online questionnaire provided to students aged between 18 and 37 years (grouped as Gen Z and Gen Y, correspondingly) by the University of Turin Communication Office. Four sections were included on the questionnaire: demographics, awareness and perception about NBS, travel behavior towards sustainability, and perception regarding the Green Crown (Corona Verde) initiative - a territorial NBS, which envisions the formation of a green belt within and around the Turin urban region (Giachino et al., 2021).

The number of valid responses amounted to 1543 that were subjected to descriptive statistics, Principal Component Analysis (PCA) for variable reduction and interpretation, Hierarchical Cluster Analysis (HCA) for the selection of respondent typologies, and Multiple Correspondence Analysis (MCA) as a means of investigating the relationship between categorical variables. Through the employment of these multi-variate methods, five respondent clusters were identified as having similar attitudes towards NBS and awareness of the Green Crown initiative (Giachino et al., 2021).

The results show that there is a more significant influence of gender as a determinant of perception and interest in NBS compared to generational cohort. Gen Y as well as Gen Z female respondents had greater awareness, positive perception towards NBS, and more intent on visiting NBS sites. Some of the male respondents had similar levels of interest but others displayed indifference or even negativism towards NBS and the Green Crown initiative. The respondents as a whole however expressed interest in NBS as potential tourism destinations with indications that NBS might be used strategically as a way of attracting green-conscious young tourists (Giachino et al, 2021).

The study further emphasizes that the success in implementing NBS requires locally adaptive, participatory techniques involving different participants right from the start. It is also crucial that digital technologies and smart technologies are embedded into the system. Youth rely heavily on social media and mobile-based platforms when arranging trips and obtaining information (Giachino et al, 2021).

In conclusion, the empirical evidence in this research offers proof of the potential of NBS not only as a type of environmental infrastructure but as youth-focused tourism and urban regeneration assets as well. It emphasizes the importance of holistic planning methods of inclusivity along with the more specific mechanisms of communicated focus and youth priorities integrated into the design and marketing of NBS.

Table 1: Overview of key Articles on Nature-Based Solutions

Author	Title	Methodology	Result	Scale	Case study	Year
Gerardo Caroppi, Francesco Pugliese, Carlo Gerundo,	A comprehensive framework tool for performance assessment of NBS for hydro-meteorological risk management	MCDA-based framework using KPIs and stakeholder weighting	Quantitative tool to compare design scenarios for risk management	Rural	hypothetical example set in a small upstream catchment representative of mountainous areas	2024
Chiara Giachino, Giulio Pattanaro, Bernardo Bertoldi	Nature-based solutions and their potential to attract the young generations	Online survey (1543 uni students, GenY & GenZ) with PCA, HCA, MCA	Females show strong positive perception; males are mixed; NBS can boost tourism	Urban	Green Crown project (Turin)	2021

Dan Zhu, Lily Fraser, Dave Kendal	Nature-based solutions in Australia: a systematic quantitative literature review of terms, application and policy relevance	Systematic quantitative literature review using PRISMA and descriptive coding from WoS and Google Scholar	In Australia, NbS definitions are inconsistent; research is concentrated in urban areas with bottom-up, local policy approaches; recommendations call for standardized definitions and integrated policy frameworks	Urban/ local	Australia, Melbourne	2023
Hilde Eggermont, Estelle Balian, José Manuel N. Azevedo	Nature-based Solutions: New Influence for Environmental Management and Research in Europe	Conceptual analysis with literature review and expert workshop input to develop a typology of NBS	Proposed a three-type typology of NBS and discussed their opportunities, risks, and challenges for environmental management in Europe	National	None	2015
Hade Dorst, Alexander van der Jagta, Rob Ravena	Urban greening through nature-based solutions – Key characteristics of an emerging concept	Literature review comparing NBS with EBA and GI	Identified core principles of NBS and suggested performance-based planning for urban greening interventions	Urban	None	2019
Aura-Luciana Istrate, Perrine Hamel	Urban Nature Games for integrating nature-based solutions in urban planning: A review	Systematic literature review; compilation of a database of 69 games and development of a conceptual framework	Identified 22 high-relevance games that are predominantly educational, target urban/city–regional scales, and promote instrumental values; discusses challenges and recommendations for using games to integrate NbS in urban planning	Urban	None	2023

Barbara Sowińska-Świerkosz & Joan García	What are Nature-based solutions (NBS)? Setting core ideas for concept clarification	Systematic review of 20 definitions and a non-systematic review to extract core ideas and exclusion criteria for NBS	Identified four core features of NBS (inspired by nature, addressing societal challenges, providing multiple benefits, and being effective/economically efficient) along with criteria to exclude non-NBS actions	Global	None	2022
Frantzeska ki et al.	Seven lessons for planning nature-based solutions in cities	A multi-case comparative analysis of data were gathered from documentary sources, in-person interviews, participant observations, and focus groups	Identified seven overarching lessons for planning, designing, and governing nature-based solutions in urban areas	Urban/local/project level	11 European cities including Antwerp, Bristol, Katowice, Malmo, Vejle, Ioannina, Potenza, Burgas, Thessaloniki, Glasgow, and Rotterdam	2019
Schaubroeck, T.	Towards a general sustainability assessment of human/industrial and nature-based solutions	Integrative review and conceptual framework development combining ecosystem service assessment and life cycle sustainability assessment, embedded within integrated earth system modeling	Proposed a general sustainability assessment framework that holistically compares mixed solutions (both nature-based and human/industrial) by focusing on their impact on human well-being	Global	European forest in Luxembourg and Belgium	2018

Richards et al.	Global variation in contributions to human well-being from urban vegetation ecosystem services	Using remote sensing, statistical modeling, and analysis of seven urban ecosystem service indicators in relation to climatic zones and the Human Development Index (HDI)	Urban vegetation significantly contributes to green space accessibility and stormwater regulation, while contributions for other services are generally lower and vary with climate and socio-economic factors.	Global	2,148 major cities worldwide	2022
Kabisch, N., Frantzeska ki, N., Pauleit, S., et al.	Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action	An inter- and transdisciplinary expert workshop (with 34 experts from seven European countries) that used panel presentations, group discussions, and a world café format to explore NbS challenges and opportunities	Identified a set of indicators for assessing NbS, highlighted key knowledge gaps and barriers, and outlined three main needs for future science and policy: (i) strengthen the evidence base; (ii) adapt governance through reflexive approaches; and (iii) integrate socio-environmental justice and social cohesion in NbS implementation	Urban	Isle of Vilm, Germany	2016
Anguelovski, I., Connolly, J. J. T., Masip, L., & Pearsall, H.	Assessing green gentrification in historically disenfranchised neighborhoods: a longitudinal and spatial analysis of Barcelona	Spatial analysis of 18 green spaces in Barcelona's socially vulnerable neighborhoods using socio-demographic indicators to assess green gentrification trends	Identified green gentrification in old industrial and historic center neighborhoods. Noted increased vulnerable residents in economically depressed and isolated areas.	Urban	Barcelona, Spain	2018

Tedesco AM et al.	The role of incentive mechanisms in promoting forest restoration	Systematic literature review (screening 1421 papers, final analysis of 73 studies) with thematic analysis using tools such as Covidence and NVivo	Socio-economic factors (e.g. governance, monitoring systems, and participant experience) are found to be critical in determining success; roughly half of the studies reported positive ecological and socio-economic outcomes, though adverse socio-economic effects were common.	project level	on the Global South (e.g. China, Brazil, among 24 countries)	2022
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2.2. Social Impact Assessment

Social Impact Assessment (SIA) was established with President Nixon signing the National Environmental Policy Act (NEPA) in 1970. NEPA mandated U.S. federal agencies to incorporate both natural and social sciences perspectives as part of their practice of decision-making, especially for those actions that would have environmental impacts (Vanclay & Esteves, 2007).

In this approach, 'social value' refers to assessment methods that go beyond traditional financial measures, factoring in the well-being of individuals and communities in meaningful goals (Napoli, 2014).

2.2.1. Overview and Analysis of Key Articles on Social Impact Assessment (SIA)

Social Impact Assessment is generally accepted as a key methodology tool for the analysis of the social implications of projects, programs, and policies. (Table .2) compiles the key studies that investigate various SIA methodologies, outputs, and uses.

Of the methods examined, there is a high prevalence of conceptual analysis and literature review. In particular, nine of them used forms of the literature review approach in combination with conceptual analysis, synthesis, and critical review (Vanclay, 2020; Vanclay & Esteves, 2015; Taylor et al., 1990; Burdge & Vanclay, 1996; Vanclay, 2006). Qualitative methods are widely adopted as well and include examples such as in-depth interviews and comparative analysis used by Rosenzweig et al. (2004) and qualitative review used by Tang et al. (2008) in the analysis of public participation and social impacts in Guangzhou.

Quantitative approaches, however less common, appear in a number of significant studies that make use of quantitative modeling and formally structured analytical approaches. Cambridge Econometrics (2015), for example, used mixed-methods involving quantitative macroeconomic modeling and micro-level analysis for the analysis of social implications of energy efficiency. A quantitative ex-ante framework was used by Desmoutier et al. (2023) in assessing the implications of Uganda's geothermal policy.

Studies vary widely in geographic and contextual scales as well. The scale of the nation is the most prevalent with five of the studies clearly classified as national-level evaluations (Hill, 2016; Cambridge Econometrics, 2015; Grieco et al., 2015; Dees et al., 2004; Taylor et al., 1990). Project-level uses follow close behind as they appear in three clear instances that range from overarching field-based cultural heritage evaluations (URS, 2013), comprehensive SWOT and SROI analysis-led framework integration (Lami & Mecca, 2021), and large-scale collaborative case surveys (Golet et al., 2006).

Moreover, regional (2) and local (2) scales are covered by influential guidelines and practical tools. For example, Dreyer et al. (2006) presented a two-layer Social Life Cycle Assessment framework with localized applicability, and the Interorganizational Committee (1994) provided regional guidelines within the context of the NEPA framework.

The cross-study syntheses outline numerous shared problems. Perhaps above all, there is great awareness of the need for systematic, standard procedures and instruments that effectively integrate qualitative and quantitative aspects. A number of the studies insist on stakeholder participation and participatory processes, especially within urban or regional regions (Sairinen & Kumpulainen, 2006; Tang et al., 2008). The evidence that emerges is that high-quality stakeholder participation has a significant bearing on the effectiveness of SIA outputs as well as their acceptance.

Overall, the reviewed studies enrich SIA methods cumulatively by both providing theoretical foundations and methodological instruments. These indicate the necessity for integrating holistic, cross-disciplinary methods for social impact appraisal in an effort to enhance policy decision-making as well as enable the sustainable and equitable outcomes within diverse contexts.

Datola and Oppio (2023) make a critical observation of how there is a necessity to develop integrated evaluation frameworks for Nature-Based Solutions (NbS) within urban systems. Datola and Oppio claim that whereas NbS are increasingly used as interventions to build climate resilience and sustainability, the social impacts of NbS - specifically focusing on equity and inclusion - remain underinvestigated (Datola & Oppio, 2023).

The authors refer to the fact that employment of NbS may produce unequal benefits to diverse society groups, with some groups, particularly poor or vulnerable members, facing the danger of exclusion from taking part in planning and benefiting from these measures. The potential of the exclusion of some groups creates the necessity to define not only ecologically suitable but also socially equitable and inclusive assessment frameworks (Datola & Oppio, 2023).

To bridge this gap, Datola and Oppio suggest a multi-dimensional and multi-methodology-based framework to value NbS. This one brings in quantitative and qualitative tools along with system dynamics-based simulation, cognition maps, GIS-based spatial analysis, and co-axial matrices. They are applied to grasp the system dynamics of the city and support the decision-making to integrate the temporal, spatial, and social impacts holistically (Datola & Oppio, 2023).

The paper highlights the importance of context-specific evaluation, that is, one grounded in the social, cultural, and institutional dynamics of the subject urban area. The paper also highlights that stakeholders are to be included from the onset in the process of assessment, a characteristic that conforms to the participatory nature of the methodology employed in the thesis by Datola & Oppio, 2023. By placing social justice and inclusivity at the central focus of evaluation strategy, the paper is in support of the methodological route of the research that employs a set of indicators that are grounded in equity to analyze the social impacts of NbS in Turin..

Table 2: Overview of Key Articles on Social Impact Assessment

Author	Title	Methodology	Result	Scale	Case Study	Year
Interorganizational Committee on Guidelines and Principles for Social Impact Assessment	Guidelines and Principles For Social Impact Assessment	Compilation of interdisciplinary guidelines, including a basic SIA model, legal mandates, and procedural steps under NEPA	Provides a comprehensive framework and set of principles for conducting Social Impact Assessments in federal contexts	Regional	U.S	1994

Louise Camilla Dreyer, Michael Z. Hauschild, Jens Schierbeck	A Framework for Social Life Cycle Impact Assessment	Combined bottom-up and top-down approach for developing the Social LCA framework	Proposed a two-layer Social LCA framework that separates obligatory impact categories (minimum societal expectations) from optional, customizable categories; introduced "Human Dignity and Well-being" as a new key area of protection.	Local	None	2006
Steven Hill	Assessing (for) impact: future assessment of the societal impact of research	A review and synthesis of literature, policy documents, and analysis of case studies from the UK Research Excellence Framework (REF)	Concludes that while challenges (e.g., time lags, attribution, and evidence issues) persist in assessing societal impact, the REF approach has largely been successful and future assessments should further integrate co-production and interdisciplinary (Mode 2) criteria	National	United Kingdom	2016
Rosenzweig, W., Clark, C., Long, D., & Olsen, S	Double Bottom Line Project Report: Assessing Social Impact in Double Bottom Line Ventures	Qualitative review and comparative analysis using in-depth interviews and documentation ; catalogs and evaluates multiple social impact assessment methods	Provides a comprehensive catalog of methods by comparing feasibility, credibility, and cost/time requirements; offers recommendations for an integrated toolkit to assess social performance	Local	San Francisco Bay Area	2004

M.Z. Hauschild, L.C. Dreyer, & A. Jørgensen	Assessing social impacts in a life cycle perspective—Lessons learned	A lessons-learned review based on four years of collaboration with industry to develop and implement a Social Life Cycle Assessment methodology; adapts environmental LCA practices for social impacts	Identifies key lessons such as the need for different tools for various applications, the importance of local specificity in data collection, challenges in quantifying and aggregating social impacts, and the necessity to link company behavior with product outcomes	Local	Not specified (general industry applications)	2008
Rauno Sairinen & Satu Kumpulainen	Assessing social impacts in urban waterfront regeneration	Post-evaluation via literature review and expert interviews; applied a typology to three Helsinki cases	Developed a four-dimension typology; Helsinki's planning generally integrates social impacts, with some variations.	Urban	Helsinki, Finland	2006
Isabella M. Lami & Beatrice Mecca	Assessing Social Sustainability for Achieving Sustainable Architecture	Integrated decision support framework combining SWOT analysis, Stakeholder Analysis (SA), and Social Return on Investment (SROI) analysis	The framework supports strategic decision-making in sustainable architecture by evaluating social sustainability, as demonstrated through a new cultural centre	Project level	Politecnico di Torino, Italy	2021

Gregory H. Golet, Michael D. Roberts, Ryan A. Luster, Gregg Werner	Assessing Societal Impacts When Planning Restoration of Large Alluvial Rivers: A Case Study of the Sacramento River Project, California	Coordinated studies using hydraulic and geomorphic modeling, socioeconomic, cultural, and public access assessments with active stakeholder engagement	Identified restoration actions that enhance both ecosystem functions (flood control, biodiversity) and human benefits (recreation, reduced flood damage); stakeholder involvement built trust and support	Regional	California	2006
Cambridge Econometrics	Assessing the Employment and Social Impact of Energy Efficiency	Mixed-methods: extensive literature review; quantitative modeling with two approaches (GEM-E3 CGE model and E3ME macro-economic model); micro-level job analysis; evaluation of social, skills, and rebound effects	Modest GDP impacts (–0.2% to +1.1%) with significant employment gains (potentially up to 4.2 million additional jobs in the EU); positive social and skills benefits	National	EU28	2015
Ozanne, J. L., Davis, B., Murray, J. B., Grier, S.	Assessing the Societal Impact of Research: The Relational Engagement Approach	Conceptual framework development using a literature review and discussion	Proposes a relational engagement framework that expands impact assessment beyond bibliometric measures to include productive interactions, enhanced capacities, and improved social networks	Local	Ghana, maternal health care in Jamaica	2017

Vanclay, F.	Conceptualising social impacts	Conceptual analysis and literature review; development of a new list of social impact indicators using an environmental function evaluation framework	Provides a comprehensive list of indicative social impacts and clarifies the distinction between social change processes and actual impacts	None	None	2002
Chanchitpricha & Bond	Conceptualising the effectiveness of impact assessment processes	Literature-based development of a criteria-based framework using a logic model approach	Proposed a comprehensive framework categorizing effectiveness into procedural, substantive, transactive, and normative criteria for IA processes	Generic (applicable across scales)	None	2013
Vanclay, F.	Social Impact Assessment (Contributing Paper)	Conceptual overview and literature review	Outlines key concepts, frameworks, and recommendations for SIA in the context of large dam projects	National	None	2000
URS	Nimba Western Area Iron Ore Concentrator Mining Project: Environmental and Social Impact Assessment – Volume 5, Part 3: Cultural Heritage Assessment	Field-based cultural heritage assessment using community surveys, interviews, and document review	Provides an in-depth evaluation of cultural heritage impacts and offers recommendations to mitigate adverse effects on local cultural and religious practices	Regional/local	Nimba County, Liberia	2013

Slootweg, R., Vancley, F., & van Schooten, M.	Function evaluation as a framework for the integration of social and environmental impact assessment	Conceptual framework development using function evaluation and literature review	Proposed an integrated framework that links social and environmental impact assessments, clarifying impact pathways and human impacts	Generic (applicable across scales)	None	2021
Cloquell-Ballester, V.-A., Cloquell-Ballester, V.-A., Monterde-Díaz, R.,	Indicators validation for the improvement of environmental and social impact quantitative assessment	Developed and tested a quantitative validation methodology (3S Methodology) for environmental and social impact indicators using observational and experimental tests on four ad hoc indicators	Proposed a robust framework for validating indicators to enhance the objectivity and reliability of quantitative impact assessments	Generic (applicable across various settings)	None	2006
Cecilia Grieco, Laura Michelini, and Gennaro Iasevoli	Measuring Value Creation in Social Enterprises: A Cluster Analysis of Social Impact Assessment Models	collected 76 SIA models from the literature and online sources, then applied a hierarchical cluster analysis to group these models into four macro-categories	capture variations in data typology, impact focus, purpose, model complexity, sector specificity, time frame, and developer characteristics	National	Netherlands	2015

Desmoitier, N., Kolenda, M., Holm Olsen, K., & Ryberg, M. W.	Methods for assessing social impacts of policies in relation to absolute boundaries	Quantitative ex-ante framework defining social dimensions, selecting indicators/thresholds; applied to Uganda's geothermal policy	Projected improvements in Energy (access: 19%→57%) and Health (life expectancy: 57.0→66.1 years); Income impact not quantified	National	Uganda	2023
Vanclay, F.	Principles for social impact assessment: A critical comparison between the international and US documents	Critical comparative analysis of the International Principles versus the US Principles and Guidelines for SIA	Identifies that the US document is positivist/technocratic while the International Principles are democratic, participatory, and constructivist; deficiencies in both are noted and the need for broader SIA approaches is emphasized	Policy level	None	2006
Vanclay, F.	Reflections on Social Impact Assessment in the 21st century	Reflective, critical review synthesizing the evolution, challenges, and future directions of SIA through literature analysis and conceptual discussion	Concludes that SIA has evolved from a regulatory tool into a comprehensive management process integrating human rights, social license to operate, and benefit sharing - while many complex challenges remain	Global	None	2020

Dees, G., Anderson, B. B., & Weiskillern, J.	Scaling Social Impact Strategies for Spreading Social Innovations	Qualitative, conceptual analysis and case study interviews; the authors examine multiple scaling examples and develop a strategic framework (the Five R's) to guide social entrepreneurs.	Proposes that social innovations can be scaled via different mechanisms (dissemination, affiliation, branching) and recommends using the Five R's (Readiness, Receptivity, Resources, Risks, Returns) to select the most effective strategy.	National	None	2004
Taylor, C. N., Bryan, C. H., & Goodrich, C. G.	Social assessment: theory, process & techniques	A comprehensive, critical synthesis that reviews the historical evolution, theoretical frameworks, processes, and techniques of social assessment through literature analysis and conceptual discussion.	Provides an integrated conceptual framework and practical techniques for conducting social assessments, highlights persistent challenges (e.g., data limitations, balancing flexibility with standardization), and draws on experiences from New Zealand and beyond.	National	New Zealand, North America, Australia, and the Pacific Islands	1990
Burdge, R. J. & Vancley, F.	Social impact assessment: A contribution to the state of the art series	A comprehensive literature review and conceptual analysis that synthesizes theoretical frameworks, definitions, and processes in SIA	Concludes that while SIA has significant potential to inform decision making when integrated with environmental assessment, persistent challenges remain in methodology, data quality, and political acceptance	Project level	None	1996

Tang, B.-S., Wong, S.-W., & Lau, M. C.-H.	Social impact assessment and public participation in China: A case study of land requisition in Guangzhou	Using qualitative methods to examine how social impact assessment (SIA) and public participation are implemented in a land requisition project in Guangzhou's Development District (GDD). The study reviews government policies, training, publicity campaigns, housing surveys, and compensation procedures.	through effective publicity, transparent procedures, and engagement of local leaders—the overall prospects for SIA and meaningful public participation in China are hindered by weak legal frameworks, state–society relations, socialist governing ideology, and traditional cultural factors.	Urban	China Guangzhou	2008
Vanclay, F., Esteves, A. M., Aucamp, I., & Franks, D.	Social Impact Assessment : Guidance for assessing and managing the social impacts of projects	Guidance note outlining good practice in SIA. It synthesizes international principles and best practice recommendations, and provides a structured framework with phases, tasks, and practical advice for SIA and social impact management.	Provides comprehensive guidance on how to plan, implement, and monitor SIA across all project phases. It stresses SIA as a continuous management process to enhance benefits, mitigate risks, and integrate social performance into project planning and decision making.	Project level	None	2015

Bo P. Weidema	The Integration of Economic and Social Aspects in Life Cycle Impact Assessment	Conceptual analysis combining cost-benefit analysis (CBA) and life cycle assessment (LCA); Proposes impact pathways for integrating social aspects into LCIA	Proposes integrating social and economic aspects into LCIA through structured impact pathways; introduces Quality Adjusted Life Years (QALYs) as a potential single-score measure for social impact	Global	None	2006
Jhon Ricardo Escorcia Hernández, Sara Torabi Moghadam, Patrizia Lombardi	Urban sustainability in social housing environments: A spatial impact assessment in Bogotá, Colombia	Spatial impact assessment using GIS tools, statistical analysis, and data engineering to evaluate 11 sustainability KPIs	Revealed distinct spatial patterns of socioeconomic inequity, showing that areas with high concentrations of social housing face disparities in urban services	Urban	Bogotá, Colombia	2024
Jhon Ricardo Escorcia Hernández, Sara Torabi Moghadam, Ayyoob Sharifi, Patrizia Lombardi	Cities in the times of COVID-19: Trends, impacts, and challenges for urban sustainability and resilience	Systematic literature review that integrates bibliometric analysis (using VOSviewer) and qualitative content analysis to synthesize literature on COVID-19 and urban sustainability	Reveals key trends, impacts, and challenges posed by the pandemic on urban sustainability – including vulnerabilities of marginalized groups, the need for resilient urban planning, sustainable mobility, and circular economy strategies	Global	Multiple urban contexts	2023

2.3. Combination of Nature-based Solutions and Social Impact Assessment

Over the past few years, there has been an increased awareness of the necessity of integrating Nature-based Solutions (NbS) with Social Impact Assessment (SIA) tools so that ecological actions taken up in cities also make significant contributions towards social equity and well-being. Although NbS provide significant environmental and climatic resilience advantages, their social aspects such as inclusion, participation, and distributional justice remain inadequately represented and superficially dealt with in both the planning and evaluation stages (Kabisch et al., 2016; Frantzeskaki et al., 2019; Snep et al., 2023).

The application of SIA within NbS planning is a systematic framework for understanding and measurement of the ways through which actions impact social groups, specifically vulnerable and historically disadvantaged people. Measurement focus for SIA lies on social indicators such as accessibility of green spaces, citizen engagement, subjective perceptions on safety, and health outcomes - factors that match well with the equity-centered promise of NbS. Escorcía Hernández, Torabi Moghadam, and Lombardi (2024), for instance, demonstrate the ease through which urban sustainability can be measured for social housing environments and use participatory KPI development together with spatial analytic tools, and indicate how data-reliant methods capture socio-spatial inequalities and support fair NbS policymaking.

In addition, the considered research literature hereunder (Tables 1 and 2) also reveals the use of interdisciplinary and participatory approaches to evaluate the social effectiveness of NbS. Overall-system, standardized indicators are emphasized as required by Caroppi et al. (2024), and Eggermont et al. (2015), and stakeholder participation and context-dependent appraisal tools to determine social impacts are espoused by Vanclay (2020), and Lami & Mecca (2021).

Connecting NbS with SIA not just deepens the analytical rigor of urban sustainability projects but makes them more practically valuable as well. This combined perspective enables planners and policymakers not only to evaluate if NbS work but for whom they work and make nature-based interventions support more equitable, just, and habitable urban spaces. In this thesis, this dual perspective is translated into practice with the identification and utilization of six of the most significant social determinants in the urban context of the city of Turin as the empirical backbone of the thesis.

Chapter 3

3. Method

This thesis starts by addressing urban inequalities in Turin by examining how Nature-Based Solutions (NbS) can foster social justice and mitigate socio-economic disparities. Recognizing urban inequalities as the primary challenge, this study focuses on evaluating the social impacts of existing NbS projects within the city through a structured and evidence-based framework.

To reach this objective, the study structured into four distinct steps, each of which will be comprehensively detailed in the subsequent sections.

Step 1 - Indicator Selection Methodology

The methodological basis of the research is to adopt a social impact assessment framework based on six social indicators first introduced by Pellerrey and Torabi Moghadam (2025). The indicators were chosen on the grounds of relevance to justice, inclusion.

Step 2 - Methodology to Define the method of assessment of each Indicator

Based on the indicator templates, a survey was constructed in a way that could reflect citizens' perceptions, experiences, and encounters with chosen NbS projects within the city. The survey comprised quantitative and qualitative items set out in accordance with the six indicators, allowing theory-based goals and empirical instruments to coincide.

Step 3 - Data collection methodology

For purposes of ensuring inclusivity and data diversification, the survey was disseminated by means of multiple channels - online and offline - to various demographic and geographical areas within the city of Turin. Collected data were then analyzed in the Google Colab environment using Python to apply indicator-specific evaluation methods to measure and understand social impacts.

Step 4 - Methodology for Data Assessment

A structured and descriptive evaluation method is applied to assess the social impacts of Nature-Based Solutions (NbS), drawing on four case studies that have been previously implemented in Turin.

Together, these steps form a coherent and methodologically rigorous path from theoretical formulation to empirical investigation, ensuring that the structure outlined in (Fig 5) is reliably reproduced in the methodology chapter.

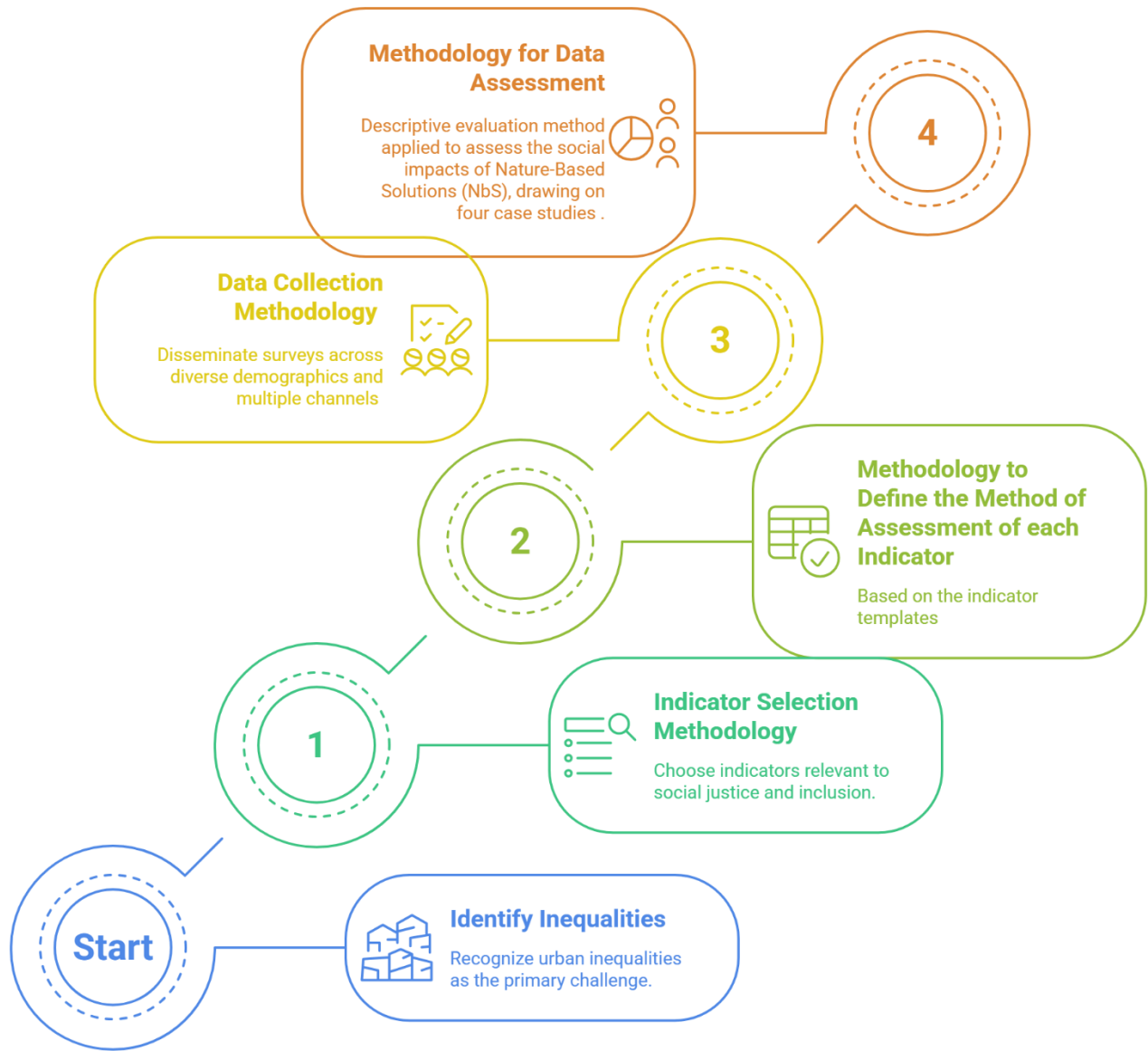


Figure 5: Thesis Methodology Flowchart

3.1. Methodology for Indicator selection

The choice of social indicators (Fig. 6) for this study was based on theoretical explanations and practical considerations, acknowledging their key role to evaluate the extent to which Nature-Based Solutions (NbS) can reduce socio-economic inequalities and promote social justice in urban areas. The clear emphasis placed on social indicators is justified by research which suggests that NbS, while being potentially positive, can further exacerbate inequalities if properly planned and evaluated based on a social equity lens (Anguelovski et al., 2018; Kabisch et al., 2016). It is therefore necessary to incorporate social elements like equity, participation, and community involvement to ensure that NbS measures are truly inclusive and fair.

Within the framework developed by Pellerey and Torabi Moghadam (2025), as presented in their article "*A Place-Based Framework for Assessing the Effectiveness of Inclusive Climate Actions for Nature-Based Solutions in Cities*," six social indicators were prioritized during one-on-one interviews with the authors:

The core indicators are:

- (1) *Citizen Involvement in Environmental Education*
- (2) *Estimated Morbidity and Mortality*
- (3) *Proportion of Citizens involved in Participatory Processes*

The supporting indicators are:

- (4) *Perceived Quality of Urban Spaces*
- (5) *Proportion of Community who Volunteer and Engaged with Projects*
- (6) *Bridging and Bonding*

Key Performance Indicators (KPIs), are numerical measures utilized to assess the effectiveness of an activity, project, or system to achieve defined strategic objectives. KPIs are tools for decision-making because they specify gaps within the performance, and hence, corrective measures are easier to take, and improvement ensues. A suitable KPI must conform to the SMART standards, i.e., Specific, Measurable, Attainable, Realistic, and Time-bound (Ke et al., 2010). KPIs are not only indispensable for use within engineering and telecom fields but are also extensively utilized within social systems, libraries, and city governments for policy-making and monitoring purposes (Pérez-Álvarez et al., 2018; Swiatek, 2019). For effective measurement, KPIs ought to be explicitly articulated in a framework connecting them to strategic targets, desired outcomes, and sources of data, hence making them relevant and comparable (Olmos et al., 2016).



Figure 6: Photos from the workshops in Brussels, Skellefteå and Torino.
(Source: Reproduced from Pellerey & Torabi Moghadam (2025)).

3.2. Methodology for Defining the assessment method for each Indicator

A standard template was created by the members of the GREEN-INC project to provide consistency in the approach and to facilitate the clearness of all the social indicators examined through this work. The template for each includes such major features as the name of the indicator, its brief description, the related macro-category, and the appropriate sub-categories. The macro-category in the overall sense is social impacts, and the sub-categories cover the theme areas of place regeneration, social justice, and social equality.

The process began with a comprehensive analysis of the pertinent literature to provide background information on each indicator. The method involved identifying research literature, policy reports, and institutional documents that place each indicator in context and clarify its relevance within the field of inclusive climate action. The analysis helped determine both the theoretical foundation and the practical applicability of each indicator.

Subsequently, procedures for measuring each indicator have been derived from the literature or developed in line with the available data and the urban context. These included the definition of units of measurement, spatial scale (i.e., district level), and the development of clear steps for data collection and analysis. Where applicable, steps in calculations and formulas have been provided in order to enable future use and replication by scholars and practitioners with diverse academic and professional training.

Each template also referred to relevant international guidelines such as the United Nations Sustainable Development Goals (SDGs) and UNESCO's Education for Sustainable Development (ESD) and national and local legislation in order to ensure alignment with broader environmental and social targets. Benchmarks and targets have been added where available from EU-27 data or national plans and where there was no such data available, a proposal for a methodological approach to setting local benchmarks was presented. This structure and evidence-based approach enabled the creation of indicators measuring quantitative and qualitative dimensions of social impact in terms of equity, inclusiveness, and participation. The indicators derived from it are intended to guide the mainstreaming of inclusive climate action into nature-based solutions and contribute to the promotion of socially just urban transformations.

3.3. Methodology for Data Collection

This research applies a logical and systematic research process in assessing the social implications of applied Nature-Based Solutions (NbS) in Turin. It offers an all-encompassing and evidence-based analysis, in accordance with tested and trustworthy research methods. The analysis pursues a multi-dimensional approach that includes several areas of social interaction, engagement, and perceived impacts in tracking and accounting for the social implications of NbS projects (Uysal et al., 2021; Dushkova & Haase, 2020).

Assessment structure consisted of three principal phases (Fig. 7). (1) Design of a Questionnaire: aimed at creating an easy-to-understand questionnaire consistent with the chosen social indicators), (2) Distribution of the Questionnaire: both in-person and through online methods in a way that assures wide coverage, (3) Data collection and cleansing: in compiling the responses, translating responses as required, and ensuring the dataset was complete and accurate in readiness for analysis. The data analysis phase is presented in detail in the following section.

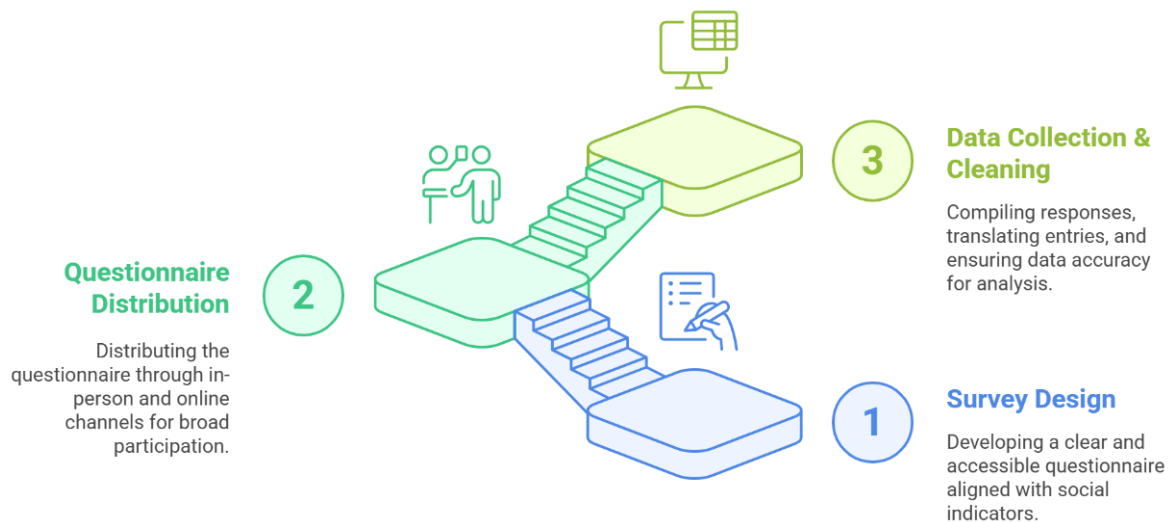


Figure 7: Flowchart of Data Collection

3.3.1. Survey Design and Development

Survey Design and Development entailed creating a comprehensive set of potential questions directly related with the identified social indicators (Eckhard, J. 2018). Together with the project team, the most suitable, clear, and concise questions were identified in order to compile the final questionnaire question (Table. 3) (Gallego Carrera & Mack, 2010). Careful selection resulted in the creation of a detailed but brief questionnaire, ensuring improved response rates by reducing the time taken for responses by citizens. Piloting of the final questionnaire was conducted with a representative sample, ensuring clarity and effectiveness in questions (Ruel, E. E., Wagner, W. E., III, & Gillespie, B. J. 2016). Systematic planning enabled easy tracking of questions that contribute to each indicator and confirmed complete coverage of the collected data (Solans-Domènech et al. 2019).

A bilingual questionnaire was crafted with careful design and translation in both English and Italian in order to maximize accessibility and usability by respondents (Nizzolino, S., Canals, A., & Temperini, M. 2023). In order to refine the questionnaire, it was piloted with a small number of participants in a workshop setting. This enabled the research team to identify and refine conflicting or duplicate questions, and adapt language for cultural and contextual appropriateness. The eventual questionnaire of 34 questions was therefore accurate and accessible. The questionnaire included a mix of multiple-choice questions, checkboxes, and comment boxes in order to gather quantitative and qualitative responses. Structured responses suitable for statistical analysis were possible with the use of multiple-choice and checkbox items, but open-ended comment boxes were able to elicit further insight into participants' attitudes.

The research methodology employed was directed at evaluating social indicators using a process of large-scale data gathering and analysis (Ferreira et al., 2020). A detailed survey was meticulously designed to evaluate the six selected social indicators. Survey questions were carefully crafted to directly measure citizen experiences, attitudes, behaviours and the survey questions related to each social indicator in Table 1 illustrate it clearly. These indicators were chosen to explore the multidimensional effects of NbS on city residents and various stakeholders, as discussed during a workshop in Torino. The goal was to gain a deeper understanding of how these solutions are perceived in terms of their social impact within the case studies (Pellerey & Torabi Moghadam, 2025).

Table 3: Definition of Survey Indicators and Their Corresponding Questionnaire Items

Macro-Category	Sub-Category	Indicator Name	Description	Survey Questions	Unit
Social Impacts	Place regeneration, Social justice and social equality	Bridging and Bonding	The result of networking outside normal social groupings (bridging) and trusting and co-operative relations between members of a network who see themselves as being similar (bonding) raising awareness of responsibility (social support)	21-How often do you participate in NbS activities that involve people from different backgrounds or social groups? 22-Do you think that NbS can help feeling connected to individuals or groups outside of your community or social circle? 23-How effective do you think that NbS are in providing opportunities for community interaction and socialization? 24-To what extent do you believe that being part of your NbS community influences your mental and emotional well-being?	N
		Estimated Morbidity and Mortality	Refers to the projection in morbidity or mortality in a population from specific health risks or environmental factors.	31- Are there specific NbS you see or engage with in your everyday life? 32- Do you think NbS contribute to your physical wellbeing? 33- Do you think NbS contribute to your mental wellbeing?	N

		Citizen involvement in environmental education activities	At least one-time active engagement of community members in initiatives aimed at raising awareness, imparting knowledge, and fostering positive attitudes and behaviors toward environmental conservation and sustainability	14-How often do you participate in environmental education activities? 15- If you participated in these education activities, could you tell us how many times? 16-Were the environmental education activities you took part in related to a specific NbS project? 17- Did you change your behaviour and attitude towards the environment after participating in environmental education activities?	N
		Perceived Quality of Urban Spaces	It can be represented by the percentage of the population that perceives urban spaces—parks, public squares, and other common use areas—around them as being of high quality. In essence, an indicator of quality regarding aesthetics, cleanliness, accessibility, safety, and functionality of urban space.	25- Are there specific NbS you see or engage with in your everyday life? 26- How would you rate the aesthetic appeal of NbS in urban spaces? 27- How satisfied are you with the maintenance of NbS? 28- How safe do you feel walking or spending time in parks and area near NbS? 29- How vibrant and lively do you find the cultural events and activities held in urban spaces near NbS? 30- How do you feel emotionally attached to NbS and areas near NbS?	N
		Proportion Citizens involved in participatory processes	Any person who takes at least one time in any social event such as a workshop in person or online.	10- Have you ever participated in community activities related to NbS? 11- If you participated in these activities, could you tell us how many times? 12- If yes, how frequently do you participate in such activities? 13- Were the activities you took part in related to a specific NbS project?	N
		Proportion of Community who Volunteer and Engaged with Projects	The percentage of individuals in a community who actively participate in volunteer activities or are engaged in local projects	18- Have you volunteered for any NBS projects? 19- If you participated in these volunteering activities, could you tell us how many times? 20- Were the volunteering activities you took part in related to a specific NbS project?	N

3.3.2. Questionnaire Distribution

After finalizing the questionnaire, we employed a multi-channel distribution mechanism for maximizing participation as well as gaining a representative respondent. The distribution process started with face-to-face administration on a public occasion in Turin city center as part of the G7 Planet Week. This was meant to obtain real-time, detailed feedback from actual residents actively participating in city life. This was supported by distributing the survey online through means like LinkedIn and WhatsApp groups. This two-pronged effort ensured both digitally active individuals and those that were contact-based were approached, thus adding diverse viewpoints into the dataset.

3.3.3. Data Collection and Cleaning

During the distribution period, there was regular monitoring in order for the survey to cover a total of 131 respondents within a month. After collecting the data, the next task was preparing the dataset for in-depth analysis. First, the raw data went through a vast amount of cleaning and pre-processing. It involved translating Italian responses on the questionnaire into English in order to facilitate homogenous analysis. Missing values in the data were handled with suitable imputation methods like Neutral or Other, depending on responses in the questions (Bruch, C. 2023; Schelter, S., 2021; Sujitha & Lavanya, 2019).

3.4. Methodology for Data Assessment

In this research, a descriptive and structured assessment methodology is employed to analyse the social impacts of Nature-Based Solutions (NbS) based on four case studies that have already been implemented in Turin. Emphasis is placed on examining how residents experience the impacts of the intervention on six chosen social indicators, namely, citizen participation in environmental education activities, perceived quality of urban spaces, percentage of citizens participating in participatory processes, percentage of the community that volunteer and are involved in projects, bridging and bonding (social cohesion), and estimated morbidity and mortality. The indicators are multi-dimensional in their portrayal of the social impacts of NbS and are drawing on analogous frameworks used in other European contexts, for instance, the CLEVER Cities Milan initiative (Mahmoud et al., 2021). The research does not attempt an effectiveness assessment of NbS intervention but rather a monitoring of perceived social impacts. Demographic information (e.g., education, gender, occupation, age) was also gathered, but this was not included in the final analysis.

Furthermore, analysis examined association patterns among chosen social indicators by means of descriptive statistics, i.e., correlation analysis and cross-tabulations. The questionnaire was carefully designed in order to analyze six major social indicators, with questions specifically designed in a manner that identifies citizen experiences, perception, and behaviors for all the dimensions (Mahmoud et al., 2021).

Chapter 4

This chapter provides an introduction to Nature-Based Solutions (NbS) in Turin city, analyzed for the district scale. The chosen case studies are a selection of the municipality's wider approaches to embedding nature in the city. They respond to Turin's increased ambitions for improving city livability and social inclusion through NbS. Not as stand-alone pilot projects, the cases here explored are part of the city's long-term planning agenda, placing NbS within the city's territorial regeneration and environmental equity drivers.

The Politiche Piemonte website recently carried an interview with Claudia Bertolotto, Turin City's Environment Director. Bertolotto also pointed out the innovation-oriented strategy of the city, with pilot plans and innovative tools aimed at reconnecting natural areas to the urban environment and recovering ecosystem processes that had been lost over time (Balma Mion & Lucchini, 2021).

This experience was also consolidated during my three-month internship with the Municipality of Turin, under Laura Ribotta and Alessandra Aires, where I worked actively on projects related to NbS. Working with the municipal team let me experience how these types of interventions are conceived, implemented, and followed up on-connecting theory with practice and enriching my knowledge on how NbS are integral to inclusive urban transformation.



Figure 8: The NBS identified by the City of Turin as strategic for increasing resilience to climate change and enhancing green areas
(Source: (Balma Mion & Lucchini, 2021))

4. Case Studies

This thesis investigates four detailed case studies situated across diverse urban contexts within the city of Turin:

- the City Water Circle project (green roof and aeroponic greenhouse)
- Orti Generali (collective food garden)
- ProGInreg Green Walls (green walls in schools and homeless shelter)
- Valdocco Vivibile (green pocket parks)



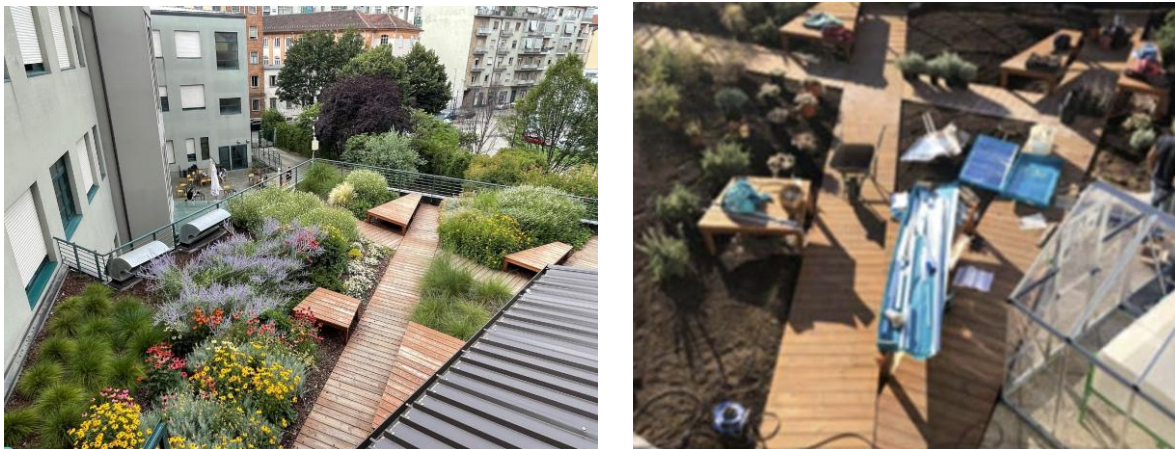
Figure 9: Location of Case Studies

4.1. City Water Circle Project: Green Roof and Aeroponic

As part of the European City Water Circles (CWC) initiative, the Municipality of Turin implemented a pilot project at Open 011 (Fig. 10) Casa della Mobilità Giovanile e dell'Intercultura, located on Corso Venezia 11. The project is built around a circular economy perspective on city water infrastructure by fostering reuse of alternative water resources, in this case through harvesting of rainwater and its inclusion in Nature-based Solutions (NbS) (Comune di Torino, 2020).

The intervention consists of the conversion of a flat roof into a green roof with an aeroponic greenhouse system, both of which are solely fed by recycled rainwater. The collected water is taken from the rooftops of the building and held in underground and terrace-level tanks. The closed-loop system keeps the water wastage to a minimum and allows year-round irrigation, capitalizing on the average annual rainfall of Turin of some 1212 mm/year (Comune di Torino, 2020).

The green roof features a variety of plant species (shrubs, perennials, ground cover, and edible ones such as strawberries, mint, aronia, cranberries, etc.), which have been chosen based on their water requirement, root growth, and adaptation capability to face the variation of seasons. Pedestrian paths and rest spaces are also provided on the site, to promote recreational and educational use both among the dwellers within the hostel and among city residents. Design is carried out with the intention to maximize biodiversity with high year-round stability and easy care and maintenance (Comune di Torino, 2020).



*Figure 10: Photo of Green Roof and Aeroponic of Open 001
(Source: (Comune di Torino, 2020))*

Next to the roof garden, a serra aeroponica (aeroponic greenhouse) was built for growing fruits and vegetables with very little water by means of an extremely efficient mist-based irrigation system. Based on filtered rainwater, the system facilitates year-round production of crops in a climatically controlled system with a very small environmental footprint (Comune di Torino, 2020). A rain garden (Giardino della Pioggia) was also developed at the ground level to collect any excess water not being harvested by the green roof or greenhouse. This natural retention basin

contains water-tolerant and local plantings, adding further stormwater management and local ecosystem benefits.

This pilot project exhibits several environmental and social advantages. Environmentally, it reduces the impacts of heat island effects in the city, enhances stormwater management, increases thermal insulation, and supports biodiversity. Socially, it creates a green shared space that enhances community interaction, environmental education, and climate action inclusion, and this is in direct alignment with the GREEN-INC project objectives as well as with the overall objectives of this thesis.

Through its integrated planning and multi-functionality, the CWC project in Open 011 demonstrates how NbS can be harnessed in the pursuit of sustainable water management and social equity in the city (Comune di Torino, 2020).

4.2. Orti Generali: Collective Food Garden

The origins of Orti Generali date back to 2010, when the project of Miraorti was initiated in Turin's district of Mirafiori Sud (Fig. 11) a city area with a post-industrial setting and widespread informal horticultural practices. The initiative began with a participative planning process that consisted of a period of four years with active participation of local associations, citizens, school, and gardeners. Three school gardens and two communal gardens developed during this initial stage were the starting point for subsequent education programs and green spaces accessible for all (Orti Generali, n.d.).

In 2018, the project developed further with the official concession of three hectares of municipal land (equal to 30,000 square meters) that facilitated its conversion into a leading social enterprise that is now Orti Generali. Today, the project is run by the original creator of Miraorti, a landscape architect named Stefano Olivari, in conjunction with Matteo Baldo, a sociologist and educator. Orti Generali combines innovation, social inclusion, and urban agriculture as a demonstrated model of city renewal (Orti Generali, n.d.).

To date, there are 170 gardens on around 12 hectares, with one hectare of informally occupied gardens repurposed as a multifunctional plot that includes an education center, urban farm, and community garden. Orti Generali is focused on accessibility and inclusion. Volunteers with limited incomes are the main contributors of volunteer time that supports the project, with a significant role in maintaining the project. Social and employment reintegration programs specifically designed for vulnerable groups are also offered through collaborative and didactic gardening (Orti Generali, n.d.).

It is not just a productive green area, but also a center of community interaction, experimentation, and environmental education. A striking feature is the Kiosk, a public center of harvested crops, mutual experiences, and learning, leading both to nutritional sustenance and social bonding. It is now a social exchange and informal learning center, with in excess of 20,000 square meters of accessible green areas (Orti Generali, n.d.).



Figure 11: Photos of Orti Generali

Orti Generali has also solidified its position as a hub of innovation by collaborating with the Departments of Agriculture, Veterinary Sciences, Biology, and Geography of the University of Turin. Through this partnership, its growth as an open-air lab, facilitating research and experimental activities in sustainable city agriculture and public involvement, has been supported (Orti Generali, n.d.).

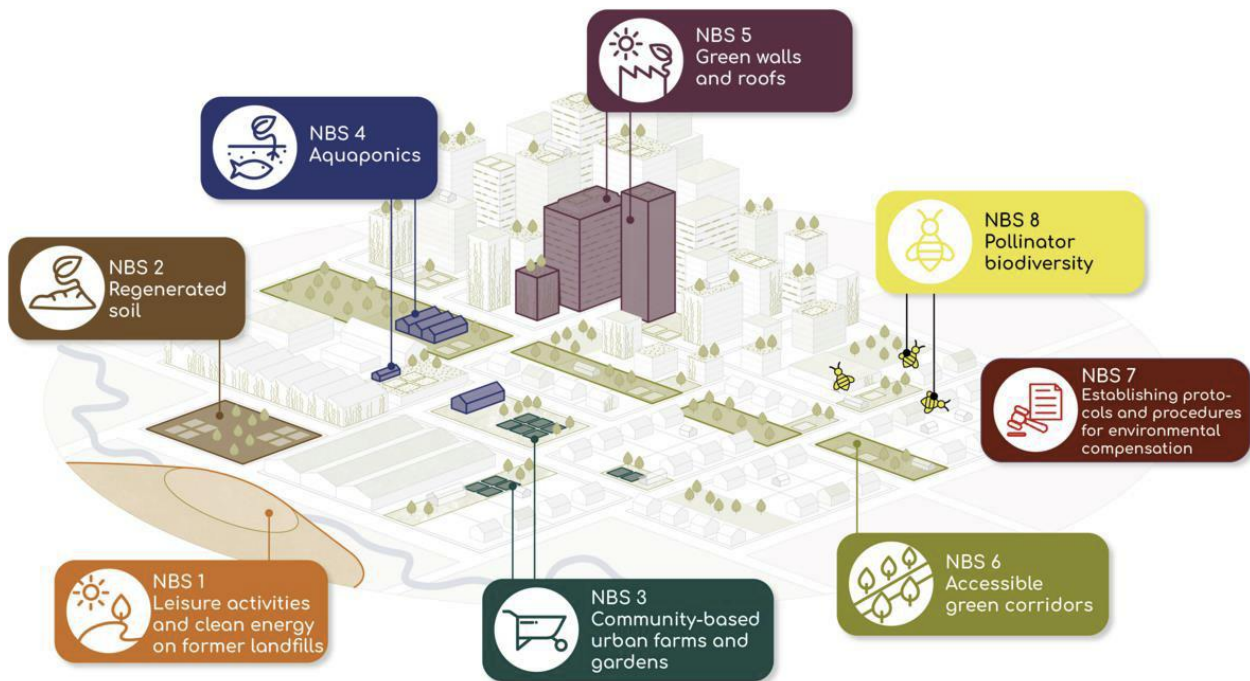
Its innovative and inclusive nature was also celebrated on a national level in 2023 with Orti Generali being awarded the National Landscape Award, then chosen to be the Italian representative in the Council of Europe Landscape Award (Orti Generali, n.d.).

4.3. ProGReg Project: Green Walls in Schools and Homeless Shelter

Under the Horizon 2020-funded ProGReg (Productive Green Infrastructure for Post-industrial Urban Regeneration) initiative, the city of Turin has deployed a set of Nature-based Solutions (NbS) with the objective of regenerating the Mirafiori Sud district. The former post-industrial district is being transformed into an experimental field for developing NbS approaches that integrate ecological innovation in conjunction with socially inclusive regeneration (ProGReg website, n.d.).

The ProGReg project website has a dedicated page that lays out the eight Nature-Based Solutions (NBS) categories applied in the project (Fig. 12). Urban green spaces have declined drastically by following traditional patterns of city growth, compromising water quality, air, soil quality, biodiversity, public health, and climate conditions. Cities need to adopt a sustainable future by promoting sustainability through green infrastructure and Nature-Based Solutions in daily cityscapes (ProGReg website, n.d.).

According to the Turin Implementation Report D3.5, Mirafiori Sud has implemented a total of 17 NBS. This includes one initiative each from NBS types 2, 4, 7, and 8, seven initiatives from NBS type 3, four from NBS type 5, and two from NBS type 6 (ProGReg, n.d.).



*Figure 12: 8 types of Nature-Based Solutions
(Source: (ProGReg, (n.d.))*

Two of the most prominent interventions within this framework include the installation of green indoor and outdoor walls and the development of an extensive green roof on a previously abandoned public building (ProGIreg, n.d.-a; ProGIreg, n.d.-b).

The first intervention was implemented in the form of two green walls placed in very symbolic and socially prominent positions (Fig. 13): an interior wall that was in the atrium of the IC Cairoli primary school and an external wall that was in a shelter for the homeless. Both walls were equipped with integrated watering systems and were built with modular green wall technology. The interior wall of 20 square meters was placed in the position that received the most natural light and with the function of providing a healthier interior environment by absorbing pollutant through plants. In parallel, the 80-square-meter external wall was developed as a free-standing vertical structure beside the shelter's facade, with the benefits of being accessible for upkeep purposes without compromising the structure of the building. Green walls were created in partnership with several local stakeholders with the City of Turin, the University of Turin, the Politecnico di Torino, and the shelter's managing NGO, Stranaidea (ProGIreg, n.d.-a).

The primary school community, students, teachers, and parents, were all involved in co-designing the intervention and with interactive modules for children for plant caring, biodiversity, and environmental education. For the homeless shelter, the wall not only beautified the structure but also acted as a platform for social reintegration through the residents' participation in maintaining the wall and taking care of it, consequently harmonizing with overall homelessness prevention policies.



*Figure 13: Photos of Green Walls in Schools and Homeless Shelter
(Source: (ProGIreg, n.d.-a))*

4.4. Valdocco Vivibile

Valdocco Vivibile is a city regeneration project (Fig. 14) that seeks to revitalize Turin's Aurora district neighborhood of Valdocco. Throughout its history, this neighborhood has been usually assigned for vehicular infrastructure, with around 90% of public areas taken up by roads, creating high traffic flows, high traffic speeds, and illegal parking. This arrangement has also resulted in environmental issues, as it has created the urban heat island effect and poor stormwater management (Torino Vivibile, n.d.).

The initiative targets the reuse of city spaces for pedestrian uses, promoting walking, social spaces, and free time areas. Through the use of green and permeable infrastructures, Valdocco Vivibile plans on adapting the neighborhood into a "climate-proof district" that is better equipped to respond to climatic exposures. This is achieved by redesigning major intersections in order to redirect vehicular traffic in a proper way, while enlarging pedestrian areas with permeable, green spaces that also regulate stormwater runoff during heavy precipitation. Minor intersections are upgraded with curb extensions and green areas for pedestrian crossing enhancement and further stormwater regulation. Pedestrian sidewalks in front of schools are broadened for the purposes of creating secure spaces for parents and students to wait. Besides, asphalted surfaces are de-paved and transformed into green infrastructure for the purpose of creating shades and cooling effects in order to counteract the problem of the urban heat island. Green spaces of different types are installed with the purpose of creating social areas for socialization in friendly spaces, and shaded paths are created for supporting slow circulation and connectivity with the city regions. Reflective material is also used in order to reduce solar radiation further, and climate-resilient public transport stations with green roofs are implemented (Torino Vivibile, n.d.).

The project's boundaries extend from Strada del Fortino in the north, Corso Regina Margherita in the south, Corso Principe Oddone in the west, to Via Cirio and Via San Pietro in Vincoli in the east. Divided into two phases, the first phase, encompassing the area south of Via Sassari and Via Robassomero, was scheduled for completion by the end of 2022 (Torino Vivibile, n.d.).



*Figure 14: Photos of Valdocco Vivibile Regeneration Project
(Source: (Torino Vivibile, n.d.))*

According to goals outlined in the Torino 2030 Action Plan, Valdocco Vivibile strives to create an accessible city that is based on quality public space, environmental sustainability, and well-being-enhancing, freedom-enhancing mobility. The project further adheres to the dictates and principles of the Climate Resilience Plan, with an aim to advance green infrastructure and construct environments that can reverse climate change effects (Torino Vivibile, n.d.).

By integrating urban design with green infrastructure, Valdocco Vivibile is an example that is replicable for other cities of similar urban texture, and it shows that solutions based on nature can be used to reinforce urban resilience, create social inclusion, and enhance overall quality of life in cities (Torino Vivibile, n.d.).

4.5. NbS Projects During Internship

During my three-month internship at the Municipality of Turin, under the supervision of Laura Ribotta and Alessandra Aires, I had the opportunity to work directly on real-life NbS projects, which provided me with valuable practical experience and deepened my understanding of how such initiatives are implemented in an urban context.

4.5.1. REACT Program

One of the major initiatives promoting large-scale urban transformation in Turin is the REACT (Resilient and Ecological Adaptation for Cities and Territories) program. The project is centered on adopting holistic Nature-Based Solutions (NbS) to create more climate-resilient and livable cities.

REACT represents a strategic turn from dispersed, localized initiatives to more coordinated, systemic actions that most closely support objectives identified in Turin's Climate Resilience Plan. By facilitating observable, scalable green infrastructure, the program assists in Turin's overall endeavor to manage climate-induced issues using multifunctional, natural approaches (Città di Torino, 2022).

The initiative focused on four key intervention areas: green public transport stops (*fermate verdi*), in (Fig.15) green tram tracks (*binari verdi*), green coverage over the Torino–Ceres railway, and the adjacent public school square, Piazzale Scuola Allievo. A fifth cross-cutting element was the emphasis on citizen communication, awareness, and engagement, although not part of the executive contract phase (Città di Torino, Divisione Infrastrutture e Mobilità n.d.).

The "*fermate verdi*" included retrofitting 15 stops of public transportation in various quarters using permeable, lightweight materials to replace impermeable pavement and adding green roofs composed of sedum to shelters. The actions were intended to minimize urban heat islands, enhance stormwater runoff, and create habitats, as well as serve as replicable urban greening examples (Città di Torino, Divisione Infrastrutture e Mobilità n.d.).

The green tram tracks (*binari verdi*) installation was executed jointly with GTT (Gruppo Torinese Trasporti) on a 200-meter section of Corso Giulio Cesare. There were three phases to the installation: the removal of asphalt from tram tracks, installation of a two-layer substrate, and addition of groundcover and sedum plant species. In addition to promoting local biodiversity, these

new green tracks also provided stormwater retention and promoted regulation of the local microclimate in an extremely trafficked corridor (Città di Torino, Divisione Infrastrutture e Mobilità n.d.).

One vital transformation also concerned the covering of the old railway trench of Torino–Ceres, which was in Circoscrizione 5. Once transformed into an extensive flooding-prone asphalted parking area, it was redesigned using permeable and reflective materials, tree planting, shaded buildings, as well as green play areas. The measures alleviated flood risks, lowered surface temperatures, and enhanced public realm quality. The nearby Piazzale Scuola Allievo was also landscaped to supply shading and interactive, didactic equipment for kids (Città di Torino, Divisione Infrastrutture e Mobilità n.d.).



*Figure 15: Photos of Green Public Transport Stops (Fermate Verdi)
(Source: (Città di Torino , Divisione Infrastrutture e Mobilità n.d.))*

In addition to physical transformations, the REACT project incorporated principles of inclusive urban design. All intervention areas were developed according to Design for All guidelines, ensuring full accessibility and usability by people of all abilities. Innovative features included interactive educational signage, smart street furniture with renewable energy functions, and activity stations converting physical movement into electricity for phone charging—designed especially for school environments. (Città di Torino , Divisione Infrastrutture e Mobilità n.d.)

Ecological elements were also critical to the design of the intervention. Rain gardens and plantings friendly to drainage were taken up extensively to control runoff and alleviate the burden on stormwater systems. Green spaces, which were well-designed in terms of stratigraphy, featured drought- and flood-resilient native plant life. Green systems, such as bioretention areas and gardens, increased biodiversity, filtered contaminants, and helped to moderate the urban climate (Divisione Infrastrutture e Mobilità, Città di Torino n.d.).

The REACT measures also promoted environmental education and public awareness. Information panels within chosen locations described the environmental role and rationale of each measure, to enlighten citizens about adaptation to climate change and NbS's role. Public engagement of

residents, schools, and decision-makers encouraged a joint sense of responsibility for transformation of the city. (Città di Torino, Divisione Infrastrutture e Mobilità n.d.)

In general, the REACT project is an innovative and ambitious model for large-scale application of Nature-based Solutions. It brings together ecology and social inclusion and long-term sustainability, which is also in line with this thesis's topics. The measures can be used as an example of replicable actions for cities that need to reconcile environmental performance and design that is centered on the community. (Città di Torino, Divisione Infrastrutture e Mobilità, no date).

4.5.2. Mennea Park

Within the process of urban renewal of Spina 1 district, Parco Pietro Mennea is an example of strategic redevelopment of post-industrial areas as inclusive, multifaceted green urban parks that serve the general public. It is one component of larger initiatives of the Programma di Riqualificazione Urbana (PRIU) that aims to redevelop hitherto industrialized, infrastructure-tied locations into sustainable, highly socialized urban spaces. The park development is situated adjacent to Piazza Marmolada, in a historically industrial zone formerly occupied by the Materferro and Itala factories, and later abandoned following industrial decline in the late 20th century. (Città di Torino, Divisione Infrastrutture e Mobilità n.d.)

The project area of about 10,000 sqm, in its first phase (Lotto 1), aims to encourage free, accessible, and inclusive outdoors and recreational activities for everyone, whatever the ages might be. The spatial composition includes different functions such as fitness areas, playgrounds, resting areas in sunny or shaded spots, and interactive pathways. Urban biodiversity, user well-being, and environmental sustainability receive special attention through elements of natural, eco-compatible, and low-maintenance design. Overall, the plan is aimed at capturing Turin's transformation of urban policy from one that is predominantly about traffic and industry to one which is, instead, about creating livable, climate-respectful urban planning. (Città di Torino, Divisione Infrastrutture e Mobilità n.d.)

In respect of green infrastructure (Fig. 16), Mennea park design included multiple layers of native and decorative plantlife, classified into organized areas like tree-lined paths, shrub hedges, and thematic decorative grass beds. For instance, two of the large tree alleys include *Acer rubrum*, *Magnolia grandiflora*, *Liquidambar styraciflua*, and *Ulmus pumila*, chosen on account of seasonal leaves and support of biodiversity. Incorporation of rich clover-planted, low-cut lawns and flowering hedges like *Forsythia intermedia* and *Nandina domestica* ensure year-round visual interest, while keeping the maintenance to a minimum. These landscape elements follow up to support the larger notion of enhancing the neighborhood character, symbolically referencing the historically used nickname, Polo Nord, used to describe the locality's extreme winter environment and industrial character (Città di Torino, Divisione Infrastrutture e Mobilità n.d.).



Figure 16: Photos of Mennea Green Infrastructure

The Parco Pietro Mennea redevelopment is an example of transforming an ageing, deteriorated industrial brownfield into an integrated social and climate-resilient ecological public space. Through a combination of climate-resilient design, green infrastructure, and community-focused functions, the redevelopment aligns very closely with and illustrates practical application of nature-based solutions to equitable and just urban renewal (Divisione Infrastrutture e Mobilità, Città di Torino, n.d.).

4.5.3. Clessidra Park

The Clessidra Verde (Fig. 17) is an urban redevelopment project designed following a participatory process to redevelop an underused public park in Turin's center into an inclusive, multifunctional urban park. The area, colloquially referred to as La Clessidra (The Hourglass), is nestled among main city corridors - Largo Orbassano, Turati's Corso, Nicola's Corso, and Via Tirreno - bounded by railway lines that curve toward Porta Susa and Porta Nuova stations. The toponym is inspired by its unusual geometric shape, while its former state was a plain green grass lawn interspersed by trees and hedges, devoid of pathways or public functions. (Città di Torino – Divisione Infrastrutture e Mobilità, n.d.).

The project resulted from Bilancio Deliberativo (Deliberative Budgeting) that is an innovative process of civil engagement encouraged by the City of Turin and coordinated by the University of Turin's Laboratorio di Politiche. The process assembled residents, experts, and public administrators to co-design proposals within an organized and participatory model of dialogue. The winning idea, Clessidra Verde, was supported by 65.6% of community votes and was centered on the idea of building a "corner of country in the city"—a park that blends ecological, educational, and recreational activities within an inclusive and community-driven design process. (Città di Torino – Divisione Infrastrutture e Mobilità, n.d.).

The park is divided into 13 thematic sections, or "petals," each with different functions and ambiance. They include sports areas fitted with artificial turf and fitness facilities, orchards and pergolas for communal seating, urban gardens with elevated beds, and playful spaces geared towards kids and adolescents. One module is an environmental learning area that houses an open-air amphitheater, fruit trees, insect shelters, fragrant herbs, and a covered metal gazebo. There is also an area that houses a landscaped hill that is used as a scenic belvedere that provides vistas over the park and urban landscape. (Città di Torino – Divisione Infrastrutture e Mobilità, n.d.).

The landscape strategy includes diverse vegetation such as *Miscanthus sinensis*, *Pennisetum alopecuroides*, *Forsythia intermedia*, and *Nandina domestica*, as well as a combination of lawns, climbing plants, and flowering shrubs to create visual interest across seasons. An underground irrigation system provides water efficiency and minimized long-term maintenance needs. The design also features vandal-proof street furniture, permeable walkways for stormwater management, and paved playing surfaces using eco-friendly materials. (Città di Torino – Divisione Infrastrutture e Mobilità, n.d.).

Significantly, the park Clessidra Verde was designed not only for, but with, local residents. Joint design entailed local expertise, local needs, and everyday necessities into the park. Its modular form provides an ability to add on and expand, with prospects of incorporating additional 'petals'

some day. Inclusive elements like shaded resting areas, accessible walkways, a special dog area (Canisette), and spaces for inter-generational play add social value and usability to the park. (Città di Torino – Divisione Infrastrutture e Mobilità, n.d.).

Clessidra Verde represents a successful example of how deliberative democracy, participatory planning, and Nature-based Solutions (NbS) can converge to produce sustainable and socially equitable urban spaces.



Figure 17: Photos of Clessidra Park, an Urban Regeneration Project Developed through a Participatory Process

4.5.4. WOW Building

The work was done on the old VOV102 building, now referred to as WOW building (Fig. 18), located on via Onorato Vigliani. The activity involved transforming part of the flat roof of the building into a green roof shaped as a meadow for pollinators.

The roof system featured several functional layers, such as anti-root waterproofing, draining elements, and a custom-designed mineral substrate. Vegetation was chosen to favor local biodiversity, especially bees and butterflies, and more than 20 local plant species created a blooming lawn. Irrigation relied on collected rainwater in an 11,000-liter tank, establishing an

autonomous water cycle. Although the roof is not open to users for safety reasons, it has promoted community interest in the building's site, spurred discussion of sustainability, and also generated plans for reusing the WOW building as a science learning center. OrtiAlti, an NGO, coordinated and executed the installation and design in collaboration with beekeepers who belong to Associazione Parco del Nobile, and Coldiretti farmers that manage the adjacent market area (ProGIreg, n.d.-b).



Figure 18: Photos of WOW Building's Green Roof System

Both green infrastructure interventions exemplify the integration of environmental performance with social inclusion. They contribute to urban resilience by enhancing ecological quality and by offering platforms for education, community engagement, and the empowerment of marginalized groups. Through participatory design and ongoing collaboration among public institutions, universities, NGOs, and residents, the ProGIreg project in Mirafiori Sud stands as a concrete example of how Inclusive Climate Actions (ICAs) can be operationalized through Nature-based Solutions. The initiatives not only improved the physical landscape but also fostered civic responsibility and environmental stewardship, demonstrating the transformative potential of NbS in achieving both ecological sustainability and social equity (ProGIreg, n.d.-a; ProGIreg, n.d.-b).

Chapter 5

5. Results

The survey results were systematically analyzed according to the methodological approach outlined previously. Each of the six selected social indicators was examined using descriptive statistical analyses, providing a clear and comprehensive understanding of the impact of Nature-based Solutions (NbS) initiatives within the Turin community.

5.1. Template of Indicators

GREEN-INC provided a indicator template for assessing indicators, which includes: short description, macro and sub category, scale, background information, assessment method, benchmark and targets and we used this method to assess the indicators.

5.1.1. Bridging and Bonding

INDICATOR NAME: Bridging and Bonding

UNITS: Number

Short Description: The result of networking outside normal social groupings (bridging) and trusting and co-operative relations between members of a network who see themselves as being similar (bonding) raising awareness of responsibility (social support)

Macro-category: Social impacts

Sub-category: Place regeneration, Social justice and social equality

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

Bridging and Bonding: the distinction between bonding and bridging social capital as variations in types of trust. Bridging social capital might be perceived as generalized trust while bonding social capital is seen as ascribed trust (van Staveren and Knorringa, 2007).

Social Support: offer individuals chances for self-assessment and affirmation of their anticipations of others. (Social Support: Theory, Research and Applications. edited by I.G. Sarason)

In explaining the diversity of social networks, an attempt must be made to approach the difference between types of contacts and types of social support. First, contacts may be distinguished as a kind of either bonding or bridging social capital. Bonding social capital can be described as relationships between persons who share a common social identity. For youths, this usually covers close and trusting relationships with parents, siblings, other family members, and also peers, characterized by similarity, trust, and frequent interactions. On the other hand, bridging social capital emanates from relationships amongst people stemming from different networks. Interaction amongst such ties involves less homogeneous similarities and less frequency of interaction,

although access is granted to resources that one could not find within the already established bonding network. (Schenk, L. 2021)

The types of social support may be distinguished in accordance with House's typology of social support, including instrumental support—applicable when concrete help is being referred to, such as time, skills, or money—emotional support—care, comfort, motivation, encouragement—and informational support—advice or guidance, for instance, in job applications or career education systems. Such supports can be given from parents, friends, teachers, or other important individuals in the life of a young person. However, different types of contacts are more likely to provide certain kinds of support. Emotional support generally arises from bonding social capital due to the trust and frequent contact involved in these relationships. By contrast, the greater relational distance and dissimilarity in bridging contacts make them less likely to provide emotional support, but more likely to provide informational and instrumental support given access to different forms of knowledge and resources.

(Schenk, L. 2021)

Key Performance Indicator: Supporting Indicators

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

The questionnaire method characterized by Mela et al. (2025) is applied in the assessment of social cohesion as an aggregate social indicator in this work. The method began through an analysis of seminal works on social support networks and social capital, including the critical aspects such as emotional bonding, intergroup relations, mutual trust, as well as perceived belongingness in the community—these being the critical determinants of social cohesion and wellbeing (Sarason, 1983; Schenk, 2021; van Staveren & Knorringa, 2007).

These theoretical foundations enabled the development of a short questionnaire with Likert-scale and multiple-choice items for the measurement of bonding (close) and bridging (cross-group) support in relation to the experience of participating in Nature-based Solutions (NbS) (Muringani et al., 2021). The questionnaire asked about the extent to which individuals participated in different social groups, the extent to which they felt connected above their own group, the extent to which NbS supported community participation, and the degree to which it influenced emotional and psychological well-being.

For the purposes of accessibility and emotional appeal, the questionnaire was designed in such a way that would be filled in less than five minutes, as recommended by Mela et al. (2025), in an effort to prevent response fatigue and maximize data richness. It was piloted during the conduct of a workshop in a university for the purposes of assessing its clarity, order, and response ordering. The experience from the pilot test was applied in the refining process for the final questionnaire. The tool was then offered in English and Italian for broad access and inclusivity (Nizzolino, Canals, & Temperini, 2023).

Following the data gathering, the dataset underwent an extensive cleaning and preprocessing process. Non-English answers were translated and the missing data were filled according to traditional imputation methods (Bruch, 2023; Schelter et al., 2021; Sujitha & Lavanya, 2018). Raw frequency counts were applied for the final analysis in Google Colab for the sake of simplicity and retrievability, with no conversion into indices.

Survey questions related to estimated Bridging and Bonding:

21- How often do you participate in NbS activities that involve people from different backgrounds or social groups?

Often Sometimes Rarely Never

22- Do you think that NbS can help feeling connected to individuals or groups outside of your community or social circle?

Very much Moderately Slightly Not at all

23- How effective do you think that NbS are in providing opportunities for community interaction and socialization?

Very effective Somewhat effective Neutral Ineffective

24- To what extent do you believe that being part of your NbS community influences your mental and emotional well-being?

Strong influence Considerable influence Little influence No influence

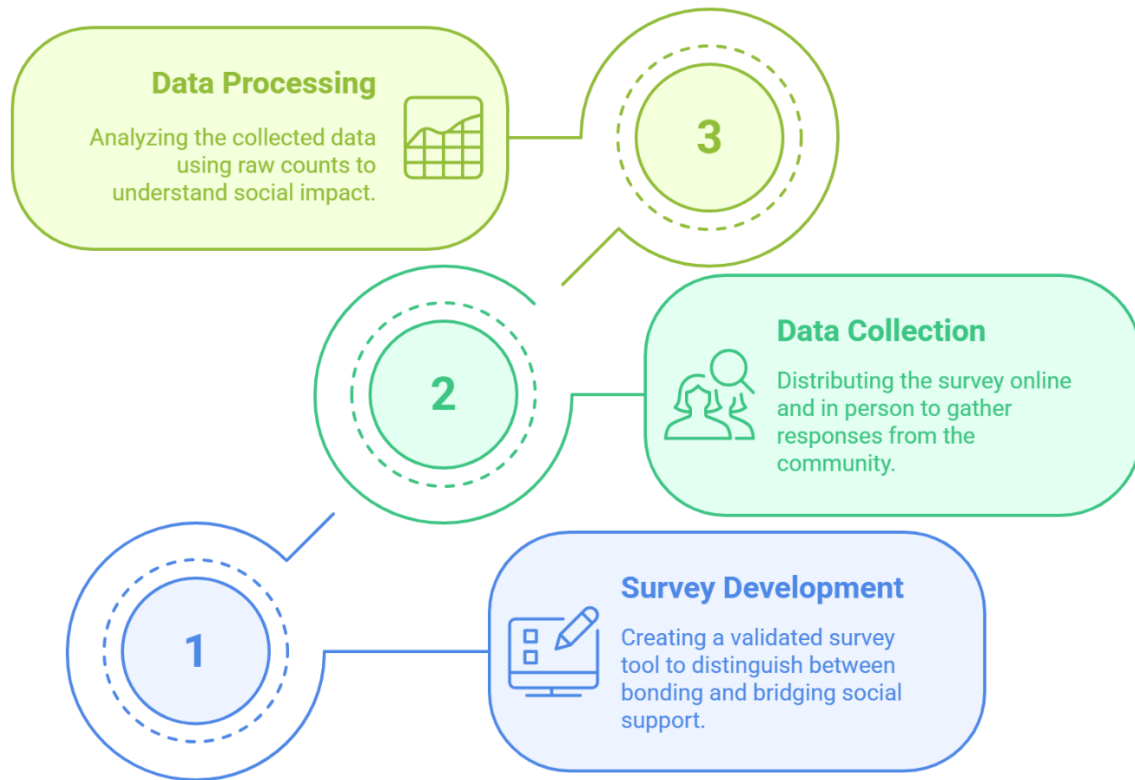


Figure 19: Flowchart of Bridging and Bonding Assessment Method

Input data: Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references

Input data	Source	Data format	Elaboration
Survey responses on perceived social support	Surveys distributed through in person and online platforms, Structured questionnaire	Categorical and ordinal responses	Aggregated survey results. responses are analyzed by counting the number of selections per category without using percentages or index scores.

BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

- Analysis finally shows that there is a positive correlation between earnings and membership in organizations - taken as proxy for bridging social capital - in the majority of countries except for a number of cases such as Belgium, Germany, Luxembourg, and Lithuania. Predictably, in most countries where the correlation does exist, wide networks turn out to be not very common and, therefore, more valuable. Wider social networks - membership in more than one organization - are, in general, associated with higher earnings. Only membership in two or more organizations is associated with higher earnings in the case of the Czech Republic, France, and Italy. While generalizing, it would appear that bridging has a stronger impact on earnings than bonding social capital, since the dispersion of more countries shows the positive effect of social networks versus family or friendship ties (European Commission, 2008).

Local references:

- Using the original Italian scale, the authors developed the PSCS-Brief Italian Version by selecting 16 key subitems structured into eight composite items representing bonding and bridging Social Capital. The different aspects of the items measure both informal networks, such as friends, colleagues, and neighbors, and more formal groups, such as community, cultural, religious, and political associations. They excluded all the items concerning family and recreational/professional associations. Results also came out to be consistent with similar studies in China, which emphasized the importance of broad connections and social influence. Due to the low explained variance from these first models, a revised model was produced that included items measuring online Social Capital (Menardo et al., 2022).

TARGETS

EU-27 References:

- It focuses on the part played by both bonding and bridging social capital within the European Union, underlining their differing influences on economic growth. While bridging social capital has generally benefited a region economically through offering higher growth rates, bonding social capital endorses greater intra-group bonds within homogenous groups. Economic growth may be hindered in cases where bonding social capital is not supplemented by bridging social capital. The most important conclusion derived from this study is that while the process of bridging facilitates knowledge sharing and innovation, there is a possibility for bonding to result in exclusive networks that limit the bigger economic impact. Bridging social capital is quite important in less-skilled regions, says the research, because it can offset lower human capital as a driver of growth by allowing a greater population to work together and solve problems effectively. (Muringani et al., 2021)

From the policy viewpoint, there are recommendations of documents to incentivize bridging social capital in growth-stimulating EU regions, especially in those areas where education levels are rather low. Here, it could substitute for human capital investment. Therefore, the negative impact of bonding social capital is greatly reduced in highly human capital regions, implying a moderating effect (Muringani et al., 2021).

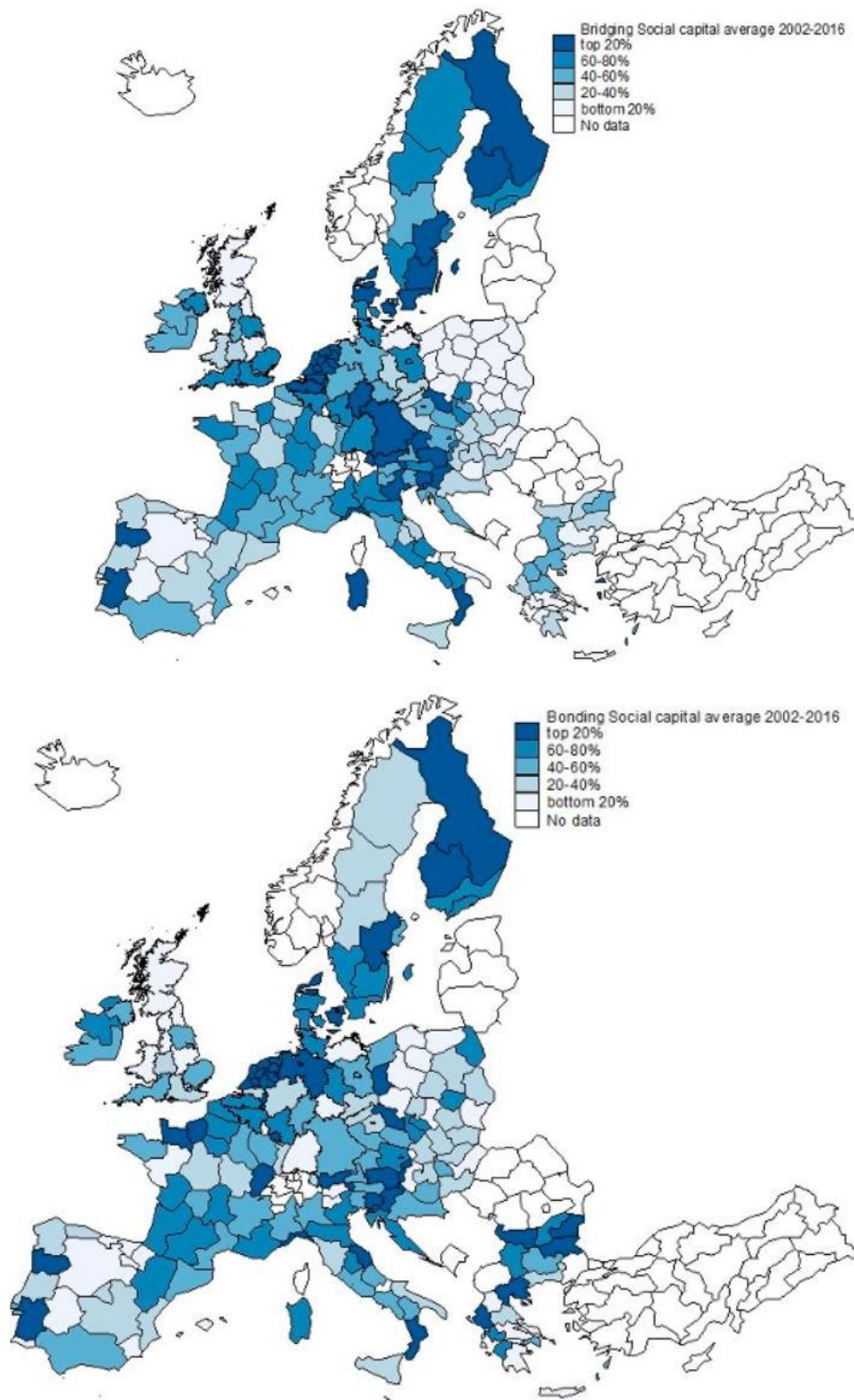


Figure 20: Bonding (top) and bridging (bottom) social capital across EU regions, 2002-2016 (ESS and EVS)

(Source: <https://cepr.org/voxeu/columns/bridging-not-bonding-regional-growth>)

Local references:

- The functions of both bonding and bridging social capital in Italy must be contextualized in the light of economic growth. In this regard, much emphasis is always placed on bridging social capital that connects different groups as a stimulant for economic growth, since such forms of capital share knowledge, innovation, and wider collaboration that accrues. Italian regions with high levels of bridging capital often boast positive economic outcomes, a higher GDP per capita, and regional development (Muringani et al., 2021).
- On the other hand, it has emerged that bonding social capital, in its role to reinforce ties within homogenous groups, tends to exert a mixed impact. While bonding may be in a position to avail social support and cohesion within the group, too much reliance on it can be associated with negative economic effects - especially when bonding leads to insular-like networks that constrain outside connections and knowledge diffusion (Muringani et al., 2021).
- The implications of such an argument for Italy, therefore, seem to be that economic growth involves a balance in these two aspects of social capital. Bridging social capital would be useful for the integration of regions into large economic networks and for development processes, particularly for regions characterized by low levels of human capital. In this respect, the study further argues that in high human capital regions, bridging can replace at least part of bonding while in regions with low human capital, bridging has to make up in lack of education and other skills (Muringani et al., 2021).

5.1.2. Estimated Morbidity and Mortality

INDICATOR NAME: Estimated Morbidity and Mortality

UNITS: Number

Short Description: Refers to the projection in morbidity or mortality in a population from specific health risks or environmental factors.

Macro-category: Social impacts

Sub-category: Place regeneration, Social justice and social equality

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

Environmental antecedents to maternal health have come to include air, water, and soil and chemical contaminants in food and consumer products. It outlines that pregnancy represents a period of unique vulnerability among women due to physiological changes associated with pregnancy that increase susceptibility to environmental toxicants. These environmental exposures are part of the multifactorial causes of various maternal health problems, including pregnancy-induced hypertensive disorders, reproductive problems related to fertility, and other long-term risks such as breast cancer and metabolic disorders. Important, the article captures that these chemical exposures are also not equitably distributed across populations. Women from racial and ethnic minority groups, as well as those from lower socio-economic backgrounds, tend to bear

higher levels of exposures contributing to health disparities. Besides chemical stressors, socioeconomic conditions are nonchemical factors that might act to aggravate such effects on maternal morbidity and mortality (Boyles, A. 2021).

The increasingly realized risk from heat waves arising due to global climate change, with related health effects, is particularly on vulnerable populations such as the elderly, urban poor, and people with chronic conditions. It outlines some strategies necessary for reducing heat-related illness and death in terms of the establishment of a heat health warning system, increased use of air conditioning, planting trees, and modifying urban environments to lower temperatures. It stresses the function of local governments in applying preventive measures when developing new decision tools, such as mapping vulnerability for the identification of the population at risk. It further discusses how embedding heat-health information into local adaptation planning enables communities to make strategic choices that maximize health benefits and cost savings (O'Neill, M. 2009).

Key Performance Indicator: KPI

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

In this study, the questionnaire approach defined by Mela et al. (2025) is used to evaluate health-related perceptions of Nature-based Solutions (NbS), specifically in relation to their influence on physical and mental wellbeing. The methodology began by reviewing key public health and environmental psychology literature, which identifies pathways through which green and blue spaces support health—such as reduction of stress, improved air quality, and promotion of physical activity (WHO, 2016; Markevych et al., 2017; Boyles, 2021).

This informed the development of a short, formal questionnaire targeting citizens' everyday experience with NbS and self-reported wellbeing. Questions married multiple-choice options with Likert-like scales, enabling participants to mark whether and in what ways NbS engagement positively affected their physical and emotional wellbeing. Design took inspiration from Smock et al. (2024), who note the utility of subjective wellbeing measures in the assessment of environmental interventions.

As is the norm according to Mela et al. (2025), the questionnaire was drafted in English and Italian, was brief in length, and would take less than five minutes to complete. It was pilot-tested for emotional relevance, accessibility, and clarity among the urban population with diverse

backgrounds. Minor wording changes were later made in response to participant comments for the final distribution.

The responses in the questionnaire, once collected, were translated and edited. The missing data were filled in through accepted practices (Bruch, 2023; Schelter et al., 2021). The data were analyzed in Google Colab in the form of raw count frequencies, with no indexing calculation, for the sole purposes of clear-cut interpretation of health-focused perceptions in the context of NbS.

Survey questions related to estimated morbidity or mortality:

31- Are there specific NbS you see or engage with in your everyday life?

Options: No / Yes, Orti generali / Yes, Valdocco vivibile / Yes, Green roof at the Open011 hostel / Yes, Green walls in Mirafiori / Other

32- Do you think NbS contribute to your physical wellbeing?

Options: Yes, a lot / Yes, a little / Neutral / They reduce my physical wellbeing

33- Do you think NbS contribute to your mental wellbeing?

Options: Yes, a lot / Yes, a little / Neutral / They reduce my mental wellbeing

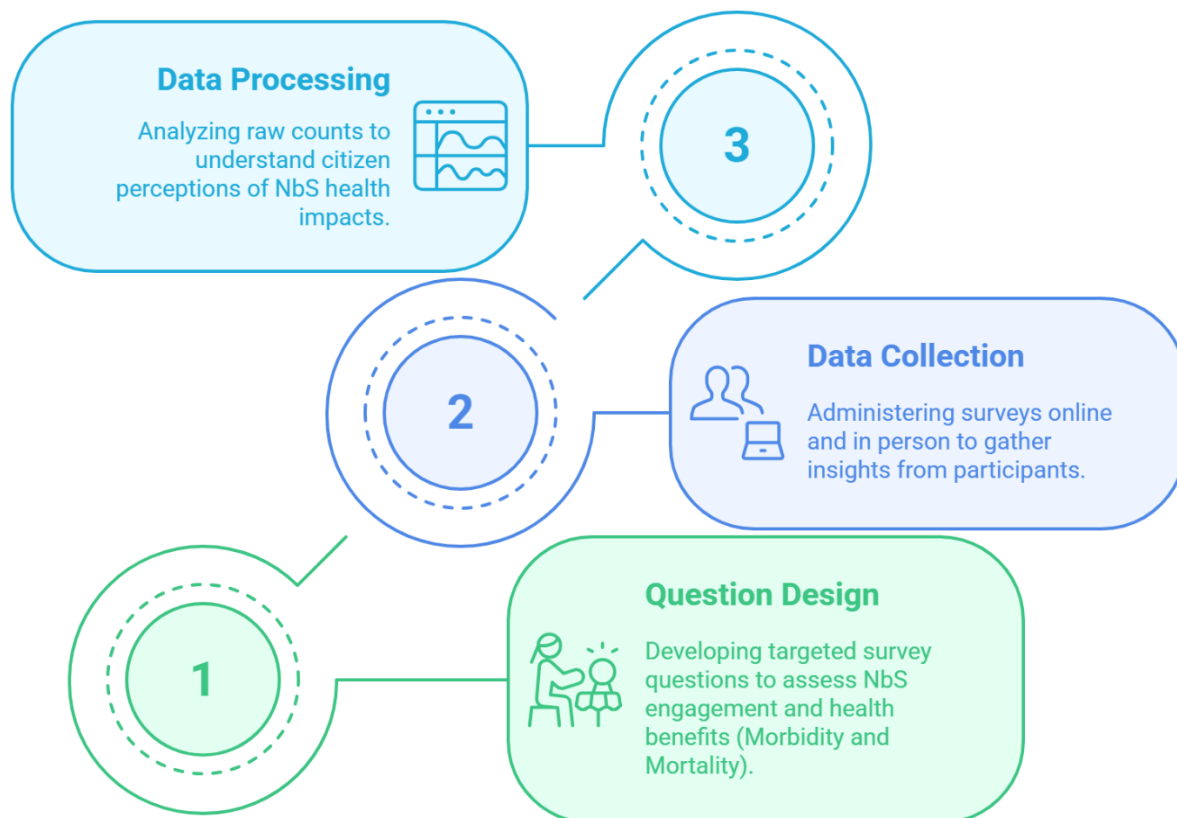


Figure 21: Flowchart of Estimated Morbidity and Mortality Assessment Method

Input data: Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references

Input data	Source	Data format	Elaboration
Responses to questions on engagement with NbS and perceived physical and mental wellbeing	Adapted from Smock et al. (2024); in-person and online distribution. Structured questionnaire.	Categorical and ordinal responses	Data collected through a structured survey assessing daily interaction with NbS and its perceived impact on physical and mental wellbeing; responses are analyzed by counting the number of selections per category without using percentages or index scores.

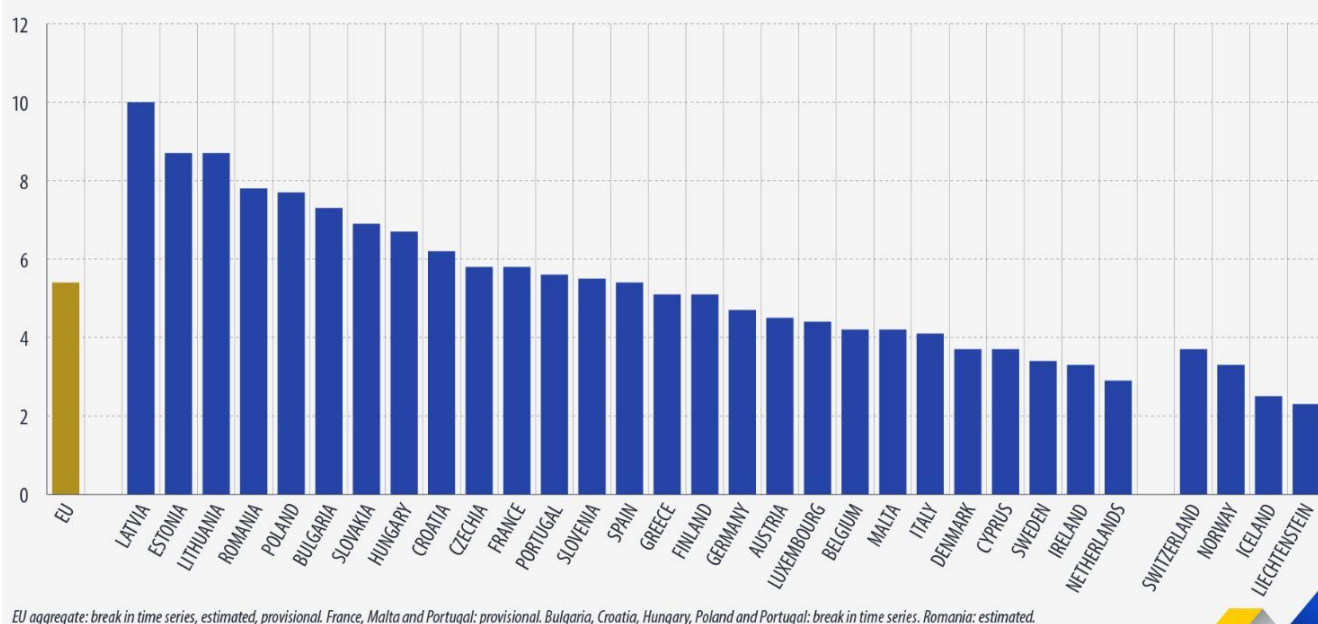
BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

Gender gap in life expectancy at birth, 2022

(years, life expectancy for women - life expectancy for men)



eurostat

Figure 22: Chart of Gender Gap in Life Expectancy at Birth, 2022

(Source: (Eurostat, 2024))

- Crude death rate, EU In the EU it was 9.9 deaths per 1,000 people in 2001, decreasing to 9.7 in both 2004 and 2006. Then, after some fluctuations, this rate increased to 10.4 in 2019, 11.6 in 2020, and 11.9 in 2021. Among the EU Member States, crude death rates rose in 22 over this period while decreasing in five. The highest rates among the EU Member States in 2021 were registered in Bulgaria, 21.7 per 1,000, Latvia, 18.4, Romania, 17.5, and Lithuania, 17.0. The lowest rates were observed in Ireland, 6.8, Luxembourg, 7.0, and both Cyprus and Malta, 8.0 (Eurostat, 2023).
- Eurostat is carrying out pilot projects with the view to having diagnosis-based morbidity data collection harmonized across Member States, to then further enhance public health surveillance and policymaking in the EU. These benchmarks focus on the incidence and prevalence of key diseases—cancer, heart disease, diabetes, and mental health. As such, the design features an Environmentally Attributable Fraction model that offers the potential to estimate the avoidable percentage of diseases by minimizing the environmental risk factors. This EAF is obtained by multiplying the incidence of a risk factor by the relative risk of disease associated with it. It would therefore be inappropriate to use a general model, since in reality, the costs at any one time are dependent on the summation of incidence of the disease and its prevalence over past time periods. This is expressed by: $\text{Costs} = \text{Disease rate} \times \text{EAF} \times \text{Population size} \times \text{Cost per case}$ wherein "Cost per case" relates to the direct healthcare expenditure, rehabilitation, and loss of productivity. Actually, data collection remains problematic because there is a difference in access and quality; for instance, some countries depend on health insurance and hospital discharge data, while others lean on surveys. In this context, Eurostat proposes the integration of various data sources and the reduction of legal and technical obstacles. Harmonized morbidity data are a precondition for resource allocation, prioritization in healthcare, and an effort to reduce health inequality. Therefore, Eurostat is developing, in close cooperation with the Member States and international organizations, a common framework for the regular collection of data, which allows evidence-based decision-making and coordination of healthcare policies within the EU (European Union, 2014).

Local references:

- Italy recorded 713,499 deaths in 2022, some 12,000 more than in 2021, though fewer than the peak mortality of 2020 that was driven by the pandemic. More than 606,000 of those deaths—or about 85% of the total—involved people aged 70 or older. In fact, the months with the highest death rates are the coldest—January and December—and the hottest—July and August—accounting for 265,000 deaths, nearly 40% of the total annual figure. This trend is generally explained by extremely bad weather affecting a growingly aging population. (ISTAT, 2023).

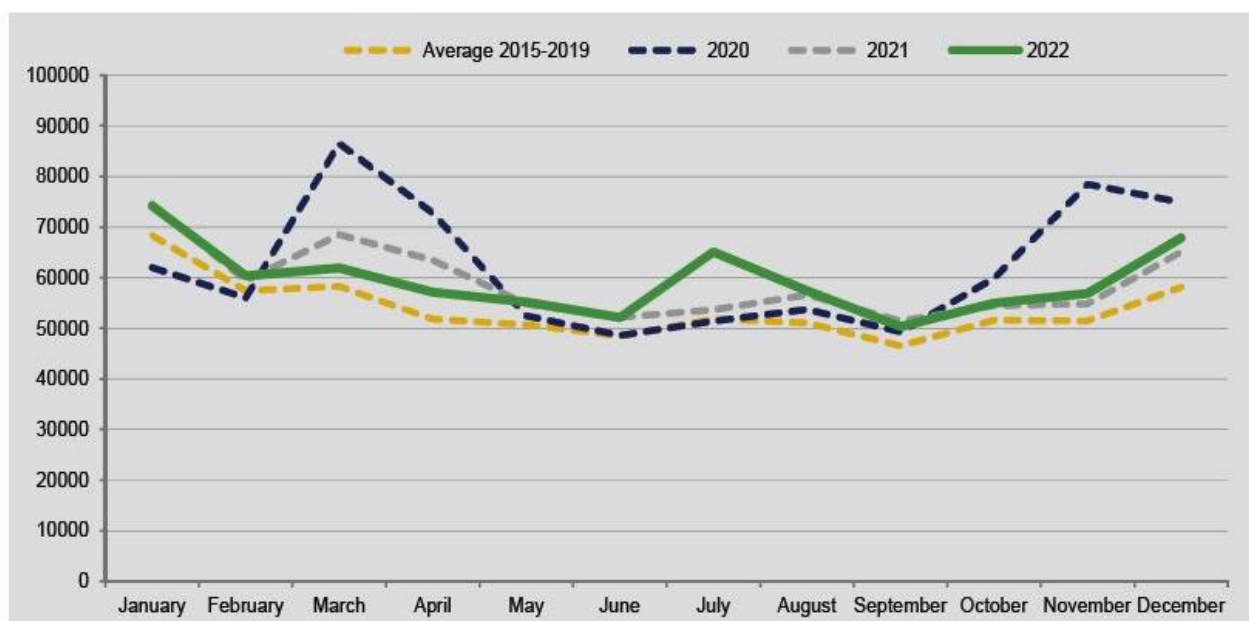


Figure 23: Chart of Total Deaths, by Months, Years 2020-2022 and Average 2015-2019
(Source: ISTAT, Italian National Institute of Health)

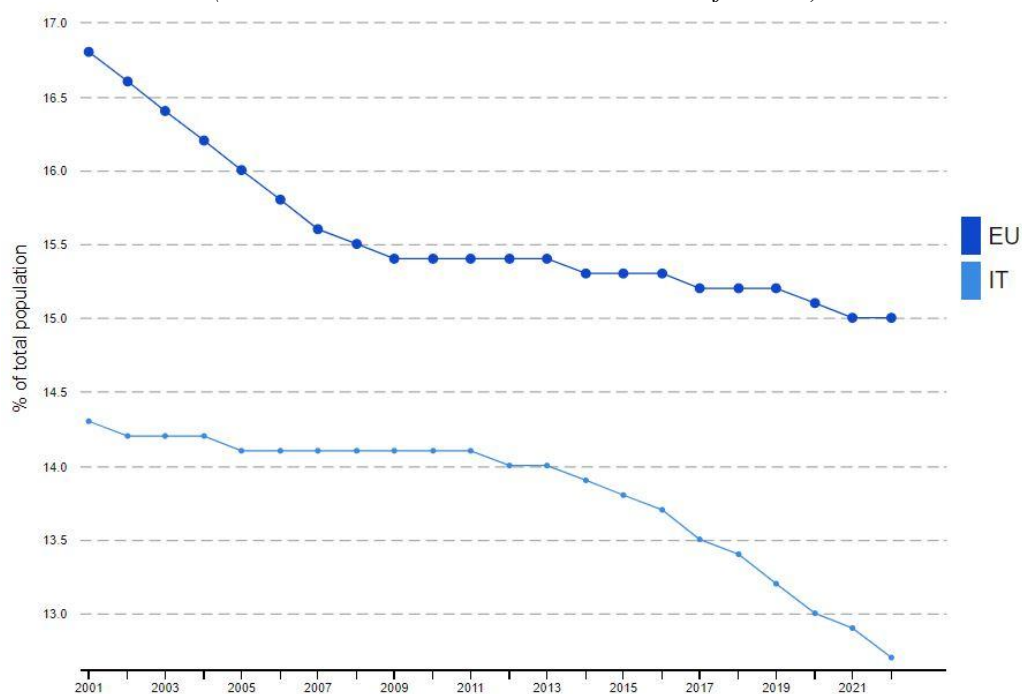


Figure 24: Chart of Population Aged Less than 15 Years
(Source: Eurostat. (2023). Demography of Europe – 2023 edition. Publications Office of the European Union)

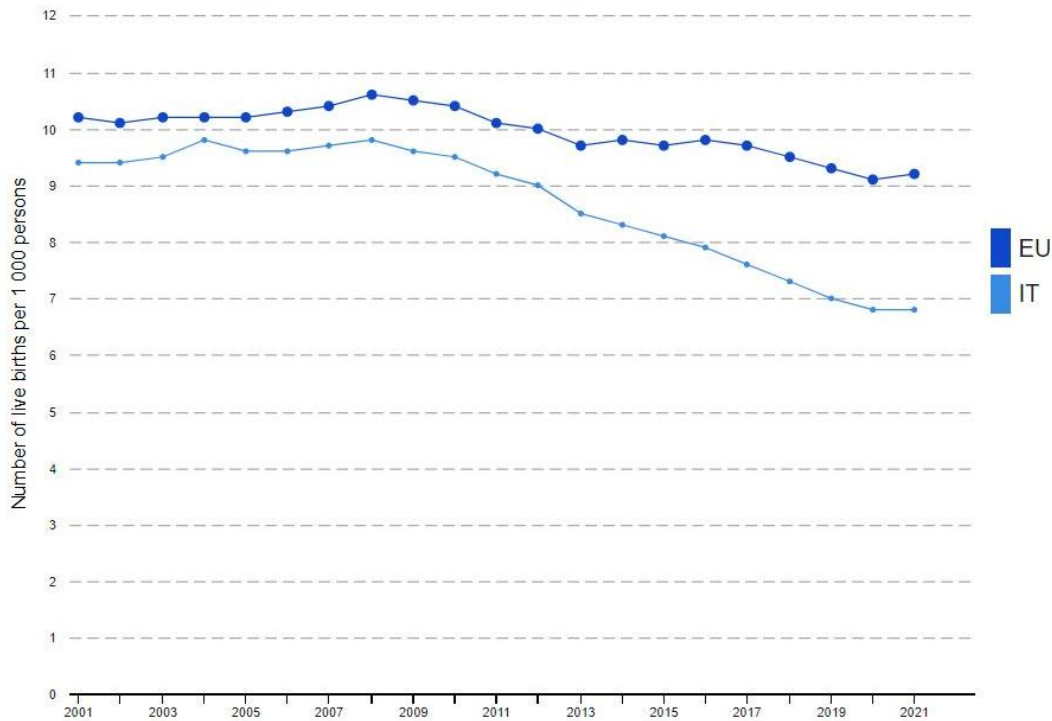


Figure 25: Chart of Crude Birth Rate

(Source: Eurostat. (2023). Demography of Europe – 2023 edition. Publications Office of the European Union.)

TARGETS

EU-27 References:

- Air pollution is responsible for causing death and disease in Europe, with the most dangerous health threats emanating from PM2.5. The European Green Deal and the European Commission's Zero Pollution Action Plan seek to enhance the quality of the air and lower premature death through air pollution by 55% by 2030, with particular emphasis on targetting the major health risk associated with PM2.5. Although premature death attributable to PM2.5 decreased by 41% between 2005 and 2021, urban EU residents still experience above WHO-recommended levels of PM2.5 in the majority. Policies such as the EU Ambient Air Quality Directives and National Emission Reduction Commitments Directive among others, have helped drive decreases in emissions from heating, transport, industrial, and agricultural sources. Given the ongoing downward trend, premature death from PM2.5 may fall below the 55% target, and it may reach as high as 68% in 2030 (European Environment Agency, 2024).



*Figure 26: Chart of Zero Pollution Action Plan 2005-2030
(Source: (European Environment Agency, 2024))*

Local references:

- Country-specific risk analysis for mortality attributable to exposure to PM_{2.5} indicates trends in support of the EU's Zero Pollution Action Plan. All EU Member States, with the exception of Poland, recorded declines in the 2005–2021 period in PM_{2.5}-related mortalities, with 14 nations reducing their rates more than in half. The reduction was reported in non-EU nations, excluding Bosnia and Herzegovina and Montenegro. Even with the reduced level of PM_{2.5}, some nations recorded higher mortality, possibly conditioned by the COVID-19 pandemic. Regionally, the most significant PM_{2.5} death rates in 2021 occurred in Bulgarian and Polish territories, while Finnish, Swedish, and Portuguese territories recorded the lowest. Regions in North Macedonia and Serbia in non-EU countries recorded high rates, while those in Iceland and parts of Norway recorded very low rates. Regions that experience high death rates often use solid fuels for heating and industrial purposes, whereas low-exposure areas experience fewer premature deaths.



*Figure 27: Chart of Countries Zero Action Plan 2005-2021
(Source: (European Environment Agency, 2024))*

5.1.3. Citizen Involvement in Environmental Education

INDICATOR NAME: Citizen involvement in environmental education activities

UNITS: % Number

Short Description: At least one-time active engagement of community members in initiatives aimed at raising awareness, imparting knowledge, and fostering positive attitudes and behaviors toward environmental conservation and sustainability.

Macro-category: Social impacts

Sub-category: Place regeneration, Social justice and social equality

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

Citizens: The citizen is the one who takes the place of the ruler in the first place. We articulate rights and responsibilities. All citizens maintain loyalty which goes to the questions of gender, race, ethnicity, or even economic class (Kerber, L. K. 1997).

Environmental Education: offers programs that afford individuals chances to discover nature outdoors, learn about conservation and environmental concerns, and acquire the knowledge and skills necessary to advocate for, safeguard, preserve, or rehabilitate the environment. (Monroe, M. C., Andrews, E., & Biedenweg, K. 2008)

Citizen involvement in activities of environmental education that are necessities in participatory approaches to solving environmental problems. It points out that there is a need for an active contribution on the part of the public toward decisions on matters involving the environment, such as community-based monitoring of the environment and public discussion of issues that involve climate and resources management, among others. It focuses on how to resolve so-called "wicked problems," highly uncertain, steeply conflicting in values, and with possibly severe consequences. (Ferkany, M., & Whyte, K. P. 2011).

Effective environmental decision-making requires the development of special participatory virtues, such as inclusiveness, reasonableness, and resilience. Such virtues help individuals to interact in constructive ways with multiple perspectives and cooperate in the discovery of mutually acceptable solutions. For Ferkany and Whyte (2011), environmental education following such an approach prioritizes the development of such participatory virtues while not relying merely on the transmission of knowledge and values. Such education helps the citizens in the handling of complex environmental issues and contributing towards sustainable solutions through collective, deliberative, and integrated participation.

Key Performance Indicator: KPI

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

In this study, the questionnaire approach defined by Mela et al. (2025) is used to assess citizen involvement in environmental education as a pathway for promoting sustainable behaviors in the context of Nature-based Solutions (NbS). The methodology began with a literature review that emphasized environmental learning, behavioral change, and participatory citizenship as key components of sustainability education (Hollweg et al., 2011; Monroe et al., 2008; Ferkany & Whyte, 2011).

These theoretical concepts informed the development of a short, targeted questionnaire, combining both multiple-choice and Likert-scale questions for assessing the frequency with which citizens engage in environmental education, the number of times they participated, whether the experiences were connected with designated NbS projects, and if the behavior or environmental attitudes were influenced post-event. The design was specifically modeled after successful environmental education models that promote reflection, place-based learning, and tracking the impact (Legge 92/2019; European Commission, 2012).

In order to maintain participant interest, the questionnaire was limited to less than five minutes in length, piloted for clarity with students and residents in Turin, and administered in both English and Italian. Revisions at the pilot stage allowed for improvement in phrasing and response alternatives.

Following the collection process, the dataset was subjected to formal cleaning, including the translation of non-English responses and the treatment of missing data through imputation (Bruch, 2023; Schelter et al., 2021). Analysis was conducted in Google Colab, using raw counts of responses instead of percentage-based measures in order to determine actual rates of participation and self-reported change in behavior.

Survey questions related to Citizen involvement in environmental education activities:

14- How often do you participate in environmental education activities?

Options: Often / Sometimes / Rarely / Never

15- If you participated in these education activities, could you tell us how many times?

Open-ended numeric response

16- Were the environmental education activities you took part in related to a specific NbS project?

Options: No / Yes, Orti generali / Yes, Valdocco vivibile / Yes, Green roof at the Open011 hostel / Yes, Green walls in Mirafiori / Other

17- Did you change your behaviour and attitude towards the environment after participating in environmental education activities?

Options: Significant changes / Minimal changes / Neutral / No changes

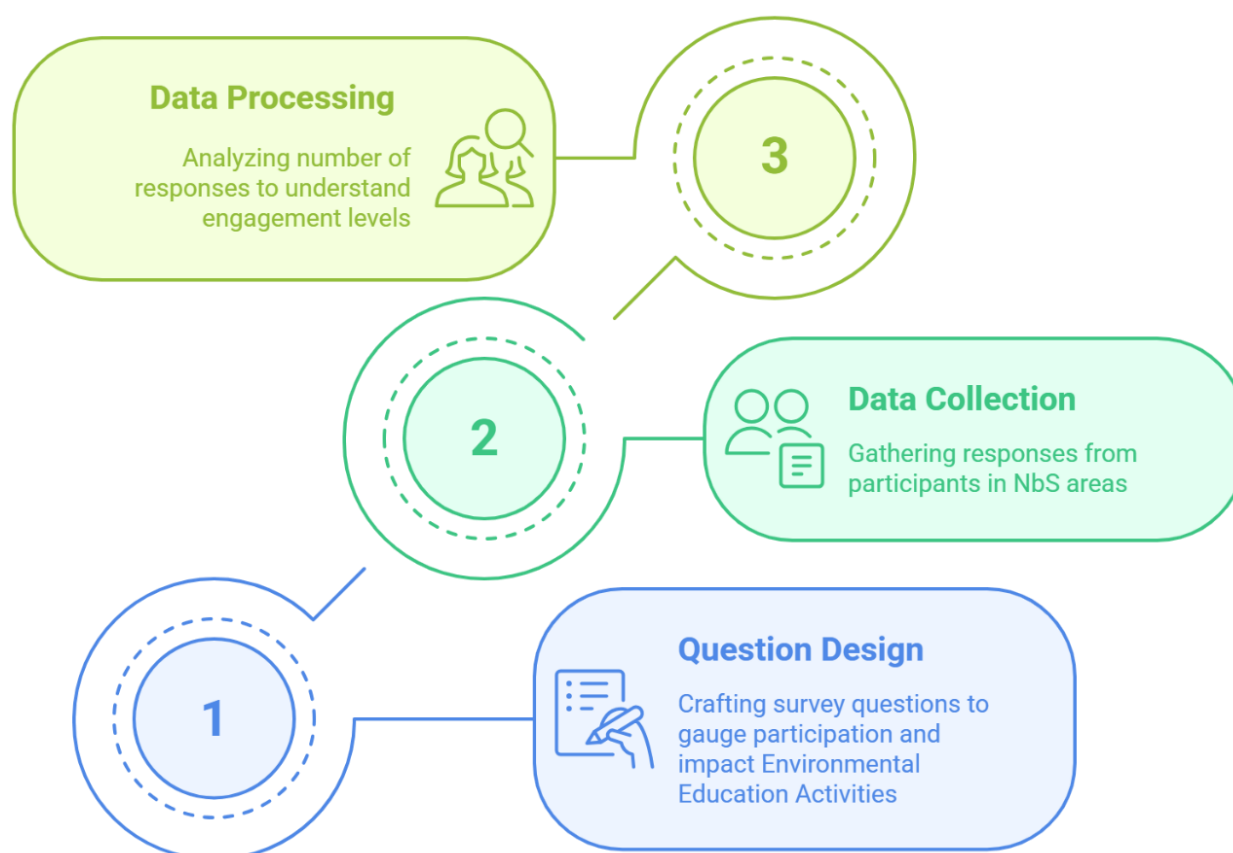


Figure 28: Flowchart of Citizen Involvement in Environmental Education Activities Assessment Method

Input data: Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references

Input data	Source	Data format	Elaboration
Environmental education program data	Environmental organizations, schools, municipalities	lists, surveys	Data from individual programs
Eligible population	Municipal population statistics	Georeferenced population data	Define the total population eligible for participation

BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

- Emphasize that democratic and participative approaches in schools must be included. It raises awareness on sustainable development and invites students to participate actively in local environmental actions. Excellent programs, such as Eco-Schools, try to involve the students directly into the process of environmental management and decision-making within the school and local community. A similar model has been available in several EU countries: Bulgaria, Latvia, Hungary, Portugal, Slovenia, and Iceland, where due to in- and out-of-classroom projects the students take part in community-based environmental activities (European Commission, 2012).

Local references:

- Civics and environmental education are promoted through Italy's program entitled Cittadinanza e Costituzione, or Citizenship and Constitution. This national program in schools of all levels was initiated in the year 2008 and is compulsory. It is aimed at signifying respect toward persons, civic responsibility as well as respect for the environment, which it will pursue with regard to the principles enshrined in the Italian Constitution. It is in this process that collaborations with local authorities, cultural associations, sports clubs, and NGOs would be promoted, further encouraging manipulative practices to environmental education and active citizenship among the students. (European Commission, 2012).

TARGETS

EU-27 References:

- The special emphases of the EU-27 targets for citizenship education are directed at student activities about civic participation, such as projects on the environment, human rights, and multicultural relations. Such activities were intended to enhance the practice of active citizenship by developing a sense of European identity and responsibility. According to reports, schools that have been able to develop a culture of participation couple with opportunities to involve students in community-based projects meet the wider aims of the EU for social cohesion and democratization in practice. (European Commission, 2012).

Local references:

- The aims established by Italy for civics education include the construction of values based on the Italian Constitution: respect for others, civic responsibility, and above all, 'responsible' consideration for the environment. The national programme "Citizenship and Constitution" presented for the first time the need for schools to construct such principles

at every grade of school. To this effect, schools should develop partnerships with local authorities, cultural associations, and other organizations. It is in this partnership that active pupils are called to participate in projects that reflect these constitutional values and, in general, the EU-27 goals of social and environmental responsibility among the young citizens. (European Commission, 2012).

- In Italy, the national education strategy for sustainability (Legge 92/2019) sets an ambitious target of reaching 30% of the population with environmental education activities by 2025. Local municipalities are expected to work with schools and NGOs to promote active citizen participation in environmental awareness and education initiatives. (Legge 20 agosto 2019, n. 92. ,2019)

5.1.4. Perceived Quality of Urban Spaces

INDICATOR NAME: Perceived Quality of Urban Spaces

UNITS: %

Short Description: It can be represented by the percentage of the population that perceives urban spaces—parks, public squares, and other common use areas—around them as being of high quality. In essence, an indicator of quality regarding aesthetics, cleanliness, accessibility, safety, and functionality of urban space.

Macro-category: Social impacts

Sub-category: social cohesion

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

Urban spaces, such as public squares, parks, and grounds for common use, perform a significant role in shaping urban quality of life and social cohesion. Spaces function in contributing environmental, physical, mental, and social needs, such as mitigating the effect of NbS, enhancing the quality of the air, reducing urban heat islands, and enhancing community wellbeing and health (Wang’ombe, 2024). The perceived quality, in the form of aesthetics, cleanliness, usability, safety, and function, affects urban residents' perception and use of the spaces (Mela et al., 2025).

Green and blue infrastructures play an important role in delivering cultural ecosystem services, involving aesthetic experiences that are linked with psychological restoration and better quality of life (Subiza-Pérez et al., 2019). Urban design and the spatial organization matter for aesthetic perception and general satisfaction with urban spaces, in supporting social contacts and the sense of community (Ahmad Nia et al., 2017; Vukovic et al., 2021).

Assessment of perceived quality consists in the evaluation both of physical characteristics and social experiences in the area, since the subjective perception on the part of the user largely determines urban value in the area (Bigdeli Rad & Ngah, 2014; Qiu & Nielsen, 2015). Therefore,

incorporating multiple views, such as community input and expert opinions, guarantees holistic urban planning and reactive public space improvements (Mela et al., 2025).

Key Performance Indicator: Supporting KPI

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

In this study, the questionnaire approach defined by Mela et al. (2025) is used to assess urban space quality as a composite social indicator. The methodology began by broadly reviewing key literature on urban space perception, which revealed vital dimensions such as availability, accessibility, safety, emotional comfort, identity, and aesthetics—all factors shown to significantly affect user experiences (Qiu & Nielsen, 2015; Subiza-Pérez et al., 2019; Ahmad Nia et al., 2017).

These conceptual foundations influenced the formulation of a compact questionnaire composed of multiple-choice questions, Likert-type scales, and open-ended items, allowing participants to express both positive and negative perceptions of urban spaces, as well as offer suggestions for improvement (Mela et al., 2025). The eight dimensions identified in Subiza-Pérez et al. (2019), for example, including mystery, harmony, multisensority, and visual spaciousness, lay the groundwork for the incorporation of items assessing emotional and sensory experiences. Likewise, the eight sensory dimensions identified by Qiu and Nielsen (2015), including serene, prospect, and refuge, provided the framework for posing questions regarding environmental safety and comfort.

In an attempt at eliciting emotional responses and an authentic response, the questionnaire was crafted specifically for the participant to answer in less than five minutes, an aspect emphasized by Mela et al. (2025) as being imperative in the prevention of response fatigue in the process of collecting rich, diverse data. The questionnaire was pilot-tested in the workshop at Politecnico di Torino for purposes such as checking on clarity, reliability, and participant comprehension. As a result of the process, the questionnaire was streamlined and refined, the responses being clear and concise. The questionnaire was then translated into English and Italian in an attempt at extending the reach into an even broader audience and being inclusive (Nizzolino, Canals, & Temperini, 2023).

After the data was gathered, the process then involved preparing the dataset for thorough analysis. First, the raw data was subjected to an intensive cleaning and preprocessing process, where non-English responses were translated and missing values were filled using proven methods (Bruch, 2023; Schelter et al., 2021; Sujitha & Lavanya, 2018). The gathered data were processed in Google Colab.

Survey question related to Perceived Quality of Urban Spaces indicator:

25- Are there specific NbS you see or engage with in your everyday life?

No Yes, Orti generali Yes, Valdocco vivibile Yes, Green roof at the Open011 hostel Yes, Green walls in Mirafiori Other

26- How would you rate the aesthetic appeal of NbS in urban spaces?

Very appealing Appealing Neutral Not appealing

27- How satisfied are you with the maintenance of NbS?

Very satisfied Somewhat satisfied Neutral Dissatisfied

28- How safe do you feel walking or spending time in parks and area near NbS?

Very safe Safe Neutral Unsafe

29- How vibrant and lively do you find the cultural events and activities held in urban spaces near NbS?

Very vibrant Vibrant Neutral Dull

30- How do you feel emotionally attached to NbS and areas near NbS?

Very attached Attached Neutral Not attached

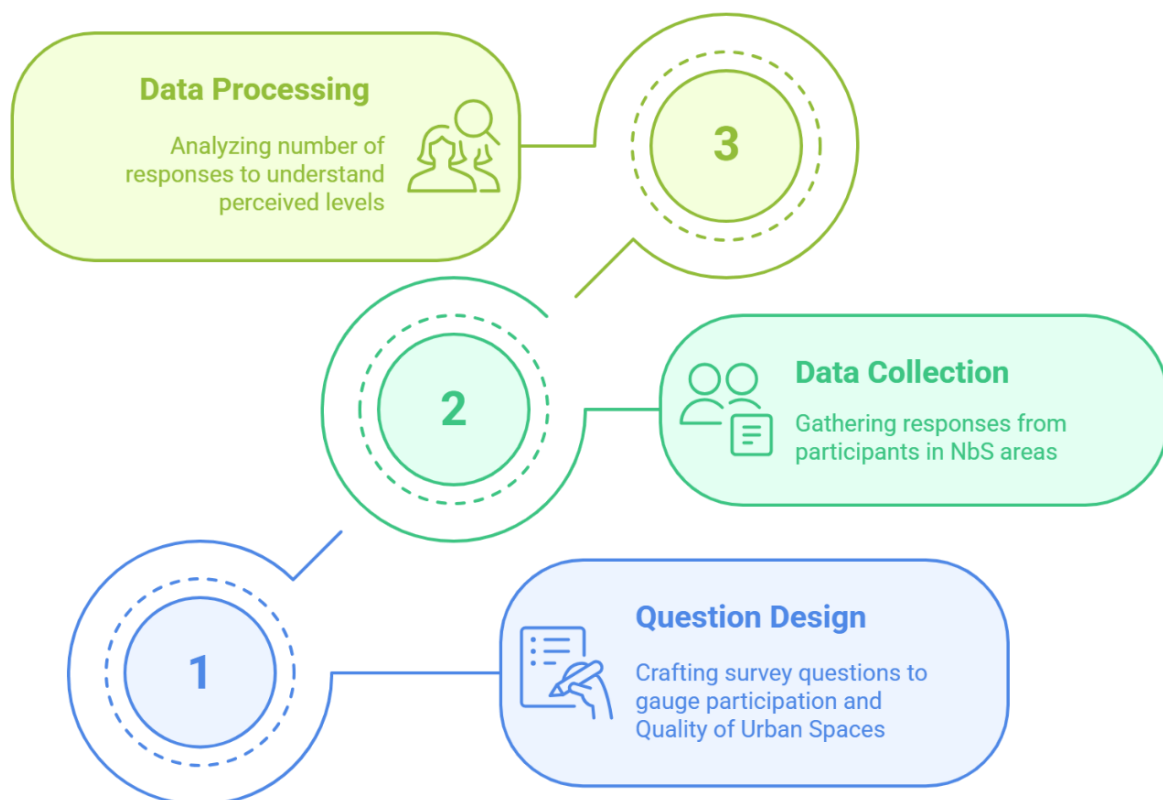


Figure 29: Flowchart of Perceived Quality of Urban Spaces Assessment Method

“suggested method”

Urban spaces affect the emotions of people, in view of advanced technology. In order to understand the impact urban environments have on human experiences, the approach suggests combining emotional and spatial data through wearable technology and geolocation tools. It captures individuals' emotional reactions in real-time while navigating urban spaces, making it easier for researchers to determine particular zones creating powerful positive and negative emotional responses and consequently assist planners in creating better, more comfortable, and user-centric environments.

Step 1: Data Collection

- **Emotional Data:**
 - Pedestrians wear body sensors—Smartbands—that monitor their physiological responses, such as skin conductivity and temperature, and their emotional states while walking in an urban environment.
 - Their movement is tracked using GPS trackers, with the exact location of participants recorded.
- **Spatial Data:**
 - Collection of the participants' geographic information system (GIS) data also occurs to document the layout, structures, and visual appearance of the urban spaces navigated by the participants.

Step 2: Experiment Design

- Participants experience a walk in a predefined route in an area of choice in an urban area that incorporates various spatial forms, such as commercial areas, residential quarters, and open spaces.
- Whereby, on the route, the participant takes pictures of the places that are meaningful according to them for the after-process of visual analysis.

Step 3: Data Preprocessing

- **Emotion Data Filtering:**
 - Processing the raw emotional data categorizes how much positive and negative emotional response comes out.
 - It uses spatial clustering techniques in the identification of areas where participants have common emotional responses, ensuring that only significant emotional responses are analyzed.
- **Isovist Generation:**
 - The generation of isovists captures the visual scope of what can be seen from the various points in the urban space.
 - This involved the calculation of the spatial parameters such as openness, building textures, and shapes at the location where the recording of emotional responses was taken.

Step 4: Spatial and Emotional Data Analysis

- **Isovist Parameter Analysis:**
 - Calculation of various isovist parameters, such as area, perimeter, compactness, visibility, among others, for each significant location.

- These parameters are then statistically analyzed in relation to the recorded emotional responses at respective locations.
- **Regression Analysis:**
 - A logistic regression model has been applied to identify the relationship between the parameters of isovist and emotional responses, positive or negative.
 - It helps to identify which spatial features - for example, openness or compactness - are most likely to influence emotions.

Step 5: Visual and Entropy Analysis

- **Photo Analysis:**
 - Photos taken by participants will then be analyzed for visual complexity using the concept of visual entropy. These serve to quantify the richness and variety of visual information.
- **Fractal Analysis:**
 - It is on this basis that fractal dimensions of photographs will be calculated in order to get an understanding of the level of complexity and order present in the environment—the extent to which the space looks natural or structured.
- A combined Visual Index is proposed by summing the measures of visual entropy and fractal measure for assessing how these factors of visual parameters influence emotional responses.

Step 6: Validation and Interpretation

- Receiver Operating Characteristic analysis was then carried out to validate the results as a means of evaluating the performance or accuracy of the predictive models utilized.
- Based on the results, the study underlines some key spatial features that have been found to affect emotions, such as compactness and visibility.

Step 7: Results Interpretation and Design Recommendations

- Finally, the results have to be interpreted and used to give practical suggestions to urban designers and planners:
 - For example, a clear boundary, greenery in space, and ordered environment in the urban spaces elicit positive emotional responses.
 - Dullness and reduced clarity in spatial boundary and cluttered layout evoke adverse feelings more easily.

(Li, Hijazi, Koenig, Lv, Zhong, & Schmitt, 2016)

Input data: *Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references*

Input data	Source	Data format	Elaboration
Survey	Turin citizen	Multiple choices	In Italian and English version
Emotional Data	Body sensors (Smartbands) worn by participants	Physiological readings (e.g., skin conductivity, temperature)	The body sensors track emotional responses (positive/negative) while participants walk through urban spaces.

BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

- The EU-27 benchmarks on perceived quality of urban spaces give the general satisfaction with public spaces such as markets, places, and pedestrian zones. Overall satisfaction rates in all surveyed cities stand at about 76%. Satisfaction is rather varied between regions: the northern and western Member States fulfill 85% and 82% of its citizens, respectively, while for the southern Member States, satisfaction is at 66%, and for the Western Balkans, the figure stands as low as 57%.

It can also be noticed that non-capital cities are usually more satisfied 78% compared to capital cities 72%. The highest satisfaction rates come from Luxembourg 92%, Groningen 90%, and Geneva 90%, while on the other side are Athens with 39%, Naples 45%, and Valletta 45%. (European Commission. 2023).

Local references:

- There are relevant differences within Italian cities in the perceived quality of urban spaces. Overall, satisfaction with public spaces is far from uniform and extends to low levels in some cities; only 45% of Naples residents and 46% of Palermo residents declared themselves satisfied with open public spaces, placing both cities among the lowest in Europe. Rome records a relatively lower satisfaction level: 56%. Besides, there are marked differences within each country; for instance, Bologna records a higher satisfaction rate as compared to southern cities such as Naples and Palermo. (European Commission. 2023).

TARGETS

EU-27 References:

- The extension of green spaces in the vicinity not only enhances cooling but reduces pollution, space for recreation, and people will be satisfied. Enhancing public space: upgrading quality, maintaining areas like markets and squares in larger cities where congestion is high enough to detract from quality. Promotion of sustainability: promoting eco-friendly practices and car independence for the EU Green Deal. Investing in cultural and social facilities will foster inclusion and address loneliness across all scales of community interaction, building social cohesion. (European Commission. 2023).

Local references:

- Italian goals include making green spaces more accessible, particularly in southern cities, in line with EU goals on green infrastructure and reducing heat islands. Quality improvements in public space are focused on areas of lower satisfaction from the part of citizens, like Naples and Palermo, and a reduction of regional satisfaction disparities that put northern cities like Bologna at higher scores compared to their southern counterparts. Social cohesion and the increase of satisfaction in urban spaces would be better achieved, it is suggested, through an increase in investment in cultural infrastructure. (European Commission. 2023).

5.1.5. Proportion of Citizen Involved in Participatory Processes

INDICATOR NAME: Proportion Citizens involved in participatory processes

UNITS:

Short Description: Any person who takes at least one time in any social event such as a workshop in person or online.

Macro-category: Social impacts

Sub-category: Place regeneration, Social justice and social equality

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

Participatory Process: Evaluating participatory processes is vital for understanding how citizens engage in democratic innovations. An essential factor for enhancing democratic involvement is the design of these processes to align with citizens' preferences. This study explores the attributes of participatory processes that influence citizen evaluations, using a conjoint analysis embedded in a representative survey of the Finnish population (Christensen, 2020).

Citizens: The citizen is the one who takes the place of the ruler in the first place. We articulate rights and responsibilities. All citizens maintain loyalty which goes to the questions of gender, race, ethnicity, or even economic class. (Linda k.-1997)

In the US, civic engagement developed in reaction to urbanization and population changes brought about in the late 19th century through industrialization and immigration. The urban areas grew rapidly as a result of immigrants from the south and eastern parts of Europe. Growth led to physical, social, and cultural changes, as well as challenges in the provision of governance as the urban areas tried to cater to large numbers. (Baum, H. S. 2015).

By the middle of the 20th century, citizen participation caught on through national programs such as President Lyndon B. Johnson's War on Poverty. The Economic Opportunity Act in 1964 sought the reduction of poverty through the participation of marginalized citizens in decision-making. The 1966 Model Cities Program promoted broad participation, and an HUD manual invoked ethnic and racial diversity on urban renewal committees. The civil rights movement further amplified citizen participation through the provision of voices for African Americans and the poor in urban areas in decision-making in their communities. It became a democratic vision and road to "first-class citizenship" for minorities.

However, local elites were opposed, insisting on limited participation in order not to relinquish power. Minority and low-income groups, largely African Americans, saw participation as the vehicle through which they could acquire control of policies in their lives. Participation broadened, assuming community participation, and the focus lay in collective participation. This broader approach insisted that entire communities, not just individuals, should have a say in decision-making.

The federal government, particularly under Johnson, saw citizen participation as a way to bypass resistant local officials and empower the urban poor. This experimental approach sought to shift power and create more equitable systems, but local officials often aimed to maintain the status quo. (Baum, H. S. 2015).

The European Commission promotes participatory governance through initiatives such as the European Citizen's Initiative and the European Democracy Action Plan Greenwood, J. (2018).

Key Performance Indicator: KPI

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

To evaluate citizen involvement in environmental education activities, this study adopts an indicator-based approach grounded in the NAAEE framework for assessing environmental literacy, which includes participation in both formal and informal educational settings as a key behavioral component of literacy (Hollweg et al., 2011).

The questionnaire method identified by Mela et al. (2025) is employed in this work for evaluating the citizens' engagement in participatory stages involving the co-design, co-implementation, and/or the feedback stages for the process of Nature-based Solutions (NbS) projects. The methodological framework is based on the wider literature in participatory planning and governance, emphasizing the participatory and democratic worth in engaging citizens in urban change (Fung, 2006; UN-Habitat, 2020; OECD, 2020)

This theoretical framework guided the design of the targeted questionnaire with the use of multiple-choice and Likert-scale questions, with the aim of capturing the quality and intensity of the public participation. In keeping with inclusive governance literature (Iveson, 2011; Eizenberg, 2012), the questions were written in such a way as to identify whether citizens participated in participative practices, the type of such participation (e.g., public meetings, surveys, workshops), and the impact it was perceived they contributed to the decision. The questions were further framed in compliance with inclusive climate action indicators included in the GREEN-INC project approach (Mela et al., 2025), with an emphasis on accessibility, transparency, and co-decision in evaluating NbS.

In order to make it user-friendly and inclusive, the questionnaire was written in such a manner that it could be filled in within five minutes, advised Mela et al. (2025). It was piloted among students and residents at Politecnico di Torino to finalize the wording and make it clear to all demographic groups. It was made available in English and Italian in order to reach the population and make it universally accessible.

After the data collection phase, the dataset was prepared for analysis through standard preprocessing steps, including translation of non-English responses and imputation of missing values (Bruch, 2023; Schelter et al., 2021; Sujitha & Lavanya, 2018). The cleaned data were then analyzed using Google Colab, where raw response frequencies were used to measure citizen involvement, avoiding index construction to ensure transparency and direct interpretation of citizen engagement levels.

Survey questions related to Proportion Citizens involved in participatory processes indicator:

10- Have you ever participated in community activities related to NbS?

Yes, once Yes, multiple times No, but I would like to No, and I am not
interested

11- If you participated in these activities, could you tell us how many times?

12- If yes, how frequently do you participate in such activities?

Not applicable Yearly Seasonal Monthly Weekly

13- Were the activities you took part in related to a specific NbS project?

No Yes, Orti generali Yes, Valdocco vivibile Yes, Green roof at the Open011
hostel Yes, Green walls in Mirafiori

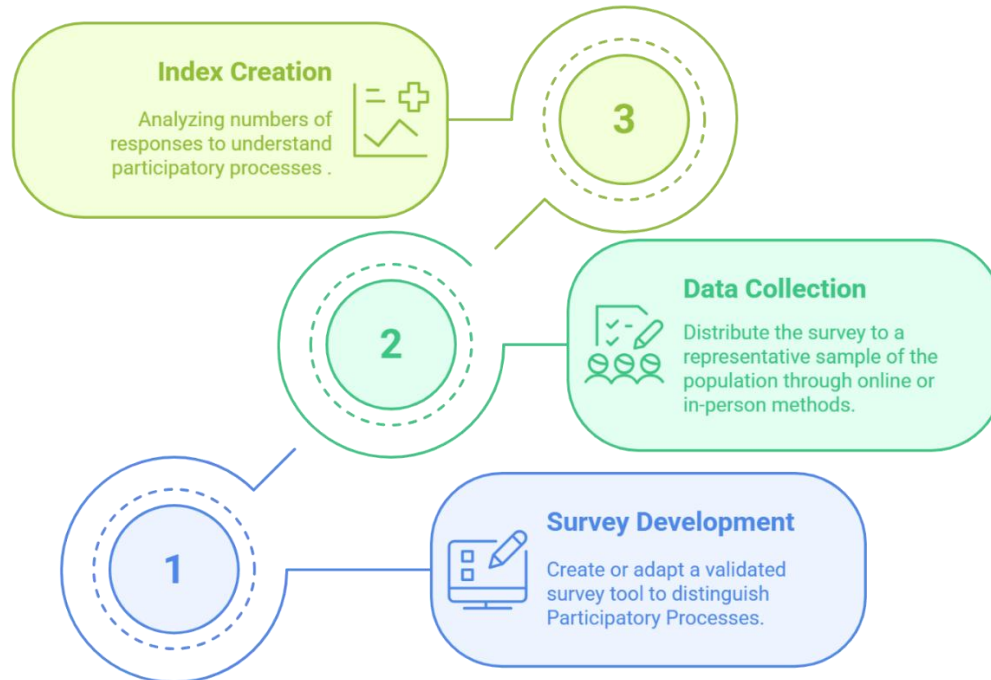


Figure 30: Flowchart of Participatory Processes Assessment Method

Input data: Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references

Input data	Source	Data format	Elaboration
Participatory events and attendance data	Municipal records, organizations	attendance lists, surveys	Data from individual events

BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

- The citizen participation initiatives in local governments in Germany and Spain are examined to probe the gap between stated aims and actual use. It shows that most local governments employ them for enhancing perceived legitimacy or rather to meet legal requirements rather than to improve decisions. The findings support institutional theory as an explanation for this practice (Royo, Yetano, & Acerete, 2011)

Local references:

- According to ISTAT (2024) in Italy, about 20% of the population in urban northern cities like Milan and Bologna is involved in any sort of civic action or participative process on an annual level. Urban planning participation has been enhanced through local laws like Legge 46/2021, and local governments increasingly make use of the co-creation process for green areas, urban transport, and schemes for social housing.

TARGETS**EU-27 References:**

- A target rate of 50% or more in the target population is required for inclusive and democratic decision-making. As stated by the European Commission (2023) and the OECD (2022), in order for participative urban governance in its metropolitan area to be appropriately developed, thresholds should be set such that more than 50% of the population should be represented through decision-making, especially for matters including public space, urban planning, and the decision-making on the environment.

Local references:

- In Italy, local governments using Legge 46/2021 should aim for 40–50% rates of engagement in urban planning activities, and specifically engage underrepresented groups such as youth, women, and low-income community areas (Italia, 2021).

5.1.6. Proportion of Community who Volunteer and Engaged with Projects

INDICATOR NAME: Proportion of Community who Volunteer and Engaged with Projects

UNITS: %

Short Description: The percentage of individuals in a community who actively participate in volunteer activities or are engaged in local projects

Macro-category: Social impacts

Sub-category: social cohesion

Scale: District

Background information: *Overview, introduce the intent of the indicator, underline importance, existing knowledge, identify whether it is being used in relevant methods and systems*

It is an indicator of active community involvement, defined by the percentage of all residents volunteering time or involved in community projects. Households that volunteer or are involved in projects in their neighborhood have shown the smoothening of social ties, the building-up of trust across community members, and a general improvement in well-being of its residents (Putnam, 2000).

Besides, common success is guaranteed with community-driven enterprises, such as projects of sustainability, neighborhood improvement, and social services, where there is a high degree of involvement (Snyder & Omoto, 2008).

While volunteering also tends to support local projects, it enhances social networking, skills, and resilience within communities. A highly engaged community has the potential to respond more proficiently to various issues, such as environmental change, economic decline, and social inequity. In highly engaged cities, locally successful projects have been able to demonstrate that high levels of local engagement are important in the context of sustainable urban development (Nurse-Bray et al., 2022).

Key Performance Indicator: Supporting KPI

CALCULATIONS

Assessment method: *specify calculation steps and formulas with sufficient level of detail and clarity so that they can be easily followed and implemented by future users that have relevant technical expertise, from different educational and professional backgrounds. If a process is too detailed and complex, for example, a detailed standard calculation procedure, then provide a simplified flowchart or other suitable overview, along with a brief elaboration of the main stages. Include relevant definitions for all parameters used, abbreviations and acronyms.*

In this study, the questionnaire method that Mela et al. (2025) describes in order to measure community volunteering and participation in Nature-based Solutions (NbS) activities. The method started with an in-depth analysis of literature pertinent to the topic and identified important elements in civic engagement like motivation, involvement frequency, place-based attachment, and self-perceived ownership in regard to urban ecological projects (Ewert & Sibthorp, 2009; O'Brien et al., 2011; Alender, 2016).

These conceptual understandings guided the design of a brief, formal questionnaire consisting of multiple-choice items and Likert scales aimed at ascertaining the extent and type of voluntary NbS-associated activities in which citizens engage. Survey questions covered informal volunteering and formal volunteering through planned community activities or municipal collaborations. Survey questions also covered the relationship between volunteering and affective attachment toward local green spaces, adapting from theories that regard participation as an entry point for environmental stewardship (Bussell & Forbes, 2002; Measham & Barnett, 2008).

To ensure usability and encourage honest responses, the questionnaire was deliberately kept brief-requiring less than five minutes to complete - in accordance with the recommendations of Mela et al. (2025). It was pilot-tested with students and residents in Turin who were actively involved in the maintenance of open spaces or engaged in urban greening activities. Feedback derived from pilot tests refined clarity and the capacity for being culturally sensitive. It was finally translated into English and Italian for the purposes of reaching an increase in the target audience and for ensuring inclusivity (Nizzolino, Canals, & Temperini, 2023).

The responses were processed and cleaned after data collection for consistency. Non-Italian responses were translated, and missing values were treated according to the methods outlined in the work of Bruch (2023), Schelter et al. (2021), and Sujitha & Lavanya (2018). The dataset that was generated was processed with the help of Google Colab, where the participants in volunteering activities were measured in quantitative numbers through the use of raw frequencies instead of index scores, thereby ensuring the clarity and transparency of civic participation in the vicinity of NbS projects.

Survey questions related to Proportion of Community Who Volunteer and Engage with Projects indicator:

18- Have you volunteered for any NBS projects?

Often Sometimes Rarely Never

19- If you participated in these volunteering activities, could you tell us how many times?

20- Were the volunteering activities you took part in related to a specific NbS project?

No Yes, Orti generali Yes, Valdocco vivibile Yes, Green roof at the Open011 hostel Yes, Green walls in Mirafiori Other

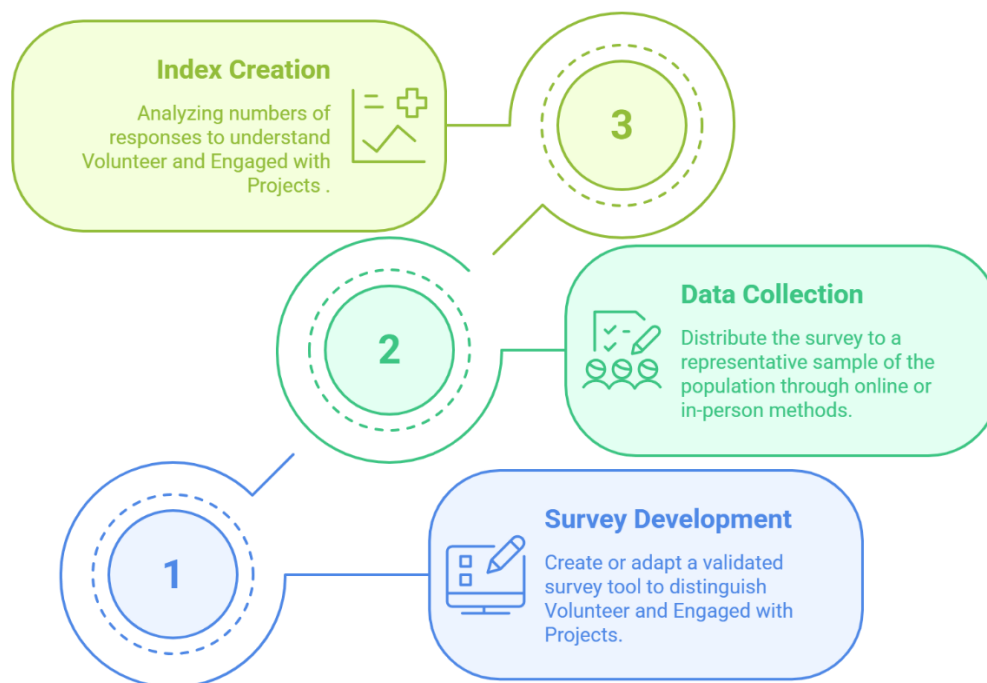


Figure 31: Flowchart of Volunteer and Engaged with Projects Assessment Method

Input data: Specify all necessary input data, identify data sources, and elaborate any necessary intermediate calculations, and sources for conversion factors. If necessary, provide additional references

Input data	Source	Data format	Elaboration
Volunteer/engagement data	Local surveys, community organizations	Numerical/percentage	Calculate proportion by Google Colab

BENCHMARKS

At least provide an EU-27 average preferably from data published by Eurostat or other EU resources or international organizations; may also consider relevant information from the literature or review papers; Where possible include national data for EU Member States. If EU/national values are not available, propose a method for possible adaptation of EU values or describe process for development at the local level

EU-27 references:

- Above 20% of Europeans take part in voluntary and charity work. The highest participation rates can be found in Denmark, Finland and Sweden where average participation by 45% of those aged 18 years and above take part in volunteering. Participation rates are between 10% and 15% in: Greece, Malta, Portugal and Spain and the newest Member States – Bulgaria and Romania. (McCloughan, Batt, Costine, & Scully, 2011)

Local references:

- In 2018, the share of people that have funded associations was 14.5%, whereas 10.5% of population performed free activities for voluntary associations or groups during the last 12 months (it was 10.4% in 2017). As it has come out from what has been seen so far, in Italy, the voluntary activity involves a reduced share of population with respect to Eu28 average. According to the studies, having a job and the presence of young children are associated with much greater difficulties in taking part in voluntary work. Both indicators do not show gender differences, while they show differences by age group. Association funding is not widespread among young people, while reaching its maximum among people aged between 45-74 years old, with values from 18% to 19%. In the case of voluntary activity, the differences between the age group are lower; the highest proportion can be found within the age group of young people, aged 14-24, and grown-up adults from 45-64. (Istat, 2019)

TARGETS

EU-27 References:

- Around 22% to 23% of Europeans aged over 15 are engaged in voluntary work, with some countries like Austria, the Netherlands, Sweden, and the UK showing more than 40% of adults participating in voluntary activities (European Commission, 2010)

Local references:

- In Italy and there less than 10% of adults are involved in voluntary activities, although it does have to be taken into account that the Italian figures only refer to the number of volunteers in specific voluntary organizations. (GHK, 2010)

5.2. Data Analysis

The analysis are based on survey results to evaluate the six social indicators. The process followed the three defined steps: Design of a Questionnaire, Distribution of the Questionnaire, and Data Collection and Cleansing. During the Design of a Questionnaire phase, each question was explicitly tailored to match one of the selected indicators. These indicators covered volunteering frequency, level of participation, perceived safety, and other themes central to evaluating social impacts. This mapping was retained in the analysis by associating each survey question with its respective data column in the cleansed Excel file.

Distribution of the Questionnaire both online and face-to-face enabled the receipt of 131 responses from a representative cross-section of the general populace and ensured a good diversity of opinion on the chosen indicators. This method of distribution, in particular on G7 Planet Week in Turin, proved essential in order to achieve the greatest possible extent of public participation. During the Data Collection and Cleansing phase, special care was taken in pre-processing the dataset for analysis. It included the removal of formatting inconsistencies like break-inhibiting characters and trailing spaces which would be detrimental to data integrity.

For each of the indicators, the analytical work began by determining absolute frequencies that is, numbers of respondents who chose each of the response options. The preference here was for clarity and usability: the presentation of the numbers unprocessed as counts, and not as proportions, maximized the ease of interpretation as a result of the fairly small as well as disproportionate sample size. The expression of the fact that '9 respondents endorsed Orti Generali' has particular relevance in this case compared with any percentage expression of this figure

For open-ended or numerical types (e.g., 'How many times have you volunteered?'), the data were cleansed of non-numeric or incorrect entries (e.g., entries like 'never' where numeric responses were expected). The most common valid responses were determined up to a maximum of 10 values per question—and graphed to show the representative levels of engagement.

For questions concerning specific Nature-based Solutions (NbS) projects, a combination of text normalization and manual keyword detection was applied. Responses were converted to lowercase and scanned for key project references (e.g., “Orti Generali,” “ProG!reg Green Walls,” “valdocco vivibile”, “City Water Circle project”). This ensured that all relevant mentions were counted regardless of differences in spelling or inclusion of multiple projects in one response.

For easy interpretation purposes, values were placed directly on each visualization. No inferential statistics or means were employed, as intended by the aim of this research: to map descriptive perception and action patterns rather than test formal hypotheses. Percentages were also deliberately eschewed since the aim was to highlight actual participation numbers and their policy and practice implications for cities.

This analytical approach accords with the general goal of the thesis to assess the impact of NbS implemented in Turin. It encourages open reporting and informs policy recommendations based on observed societal behavior and thus leads to inclusive and data-informed urban sustainability planning.

5.2.1. Demographic Analysis

The 131 survey respondents from Turin are presented through four bar charts - Figure 32: Age Distribution, Figure 33: Gender Distribution, Figure 34: Educational Background, and Figure 35: Occupation - offering insight into their age, gender, education, and occupational status.

(Fig. 32) indicates that the majority of the participants belong to the 20–30 age bracket, with 75 individuals. The prevalence of young adults in the sample indicates a high level of participation of young adults in environmental and urban issues from which this sample has emerged. The second highest cohort of ages represented is 30–40 years old and consists of 24 respondents and 13 participants who aged above 60 years old, 8 respondents who aged between 40–50 years old, and only 2 participants aged below 20 years old.

The distribution indicates a heavy concentration of young adults in the sample and lesser contributions of middle-aged and older citizens in what may shape the perceptions reflected through the analysis, especially when considering long-term urban experience and intergenerational demands.

(Fig. 33) shows a higher proportion of female interviewees at 79 compared to 51 males participating in the survey. The predominance of females offers a window for investigating gender-specific aspects concerning perceptions of Nature-based Solutions (NbS), e.g., safety, social cohesion, and aesthetic appeal, which tend to be influenced by gendered urban experiences. The even split between the two central gender groups also favors a non-discriminatory decoding of responses in this dimension.

Educationally speaking, as seen from (Fig. 34), the sample survey consists mainly of highly educated individuals. Seventy-eight out of the respondents hold a Master's degree and hence remain the most representative education level of respondents. This is followed by 26 respondents who hold a Bachelor's degree and 16 who hold a high school diploma and 10 who hold a PhD. The high level of educational qualification of respondents can be explained by the circulation of the survey in academic or professional communities. While this maximizes the analytical level in responses received, it also poses a threat of a sampling bias since it has the capacity to underrepresent the opinions of less highly educated respondents who might engage differently with urban public spaces or experience other obstacles in accessing NbS.

(Fig. 35), the occupation chart also mirrors the distribution of the sample by education and age. Students comprise the majority at 64, followed by 50 working respondents, showing a preponderance of the sample in education or professional employment. 10 of the sample are also retired and 6 unemployed. The prevalence of students mirrors the sample's youth profile and indicates why the sample might not be representative of the views of economically vulnerable or older communities.

Considered together, these demographic findings offer critical context for the interpretation of the survey results. Although the data indicates high levels of engagement among young, highly educated, and professionally active individuals—presumably a segment of the population expected

to be better educated and engaged on the question of sustainability - there also exists the limitation of a lack of representativeness. In particular, the underrepresentation of older adults, less educated individuals, and those not in employment or education must be taken into account when making generalizations about the social effects of NbS in Turin. The credibility and inclusivity of the study's conclusions would be enhanced by a mention of this methodological or discussion section limitation.

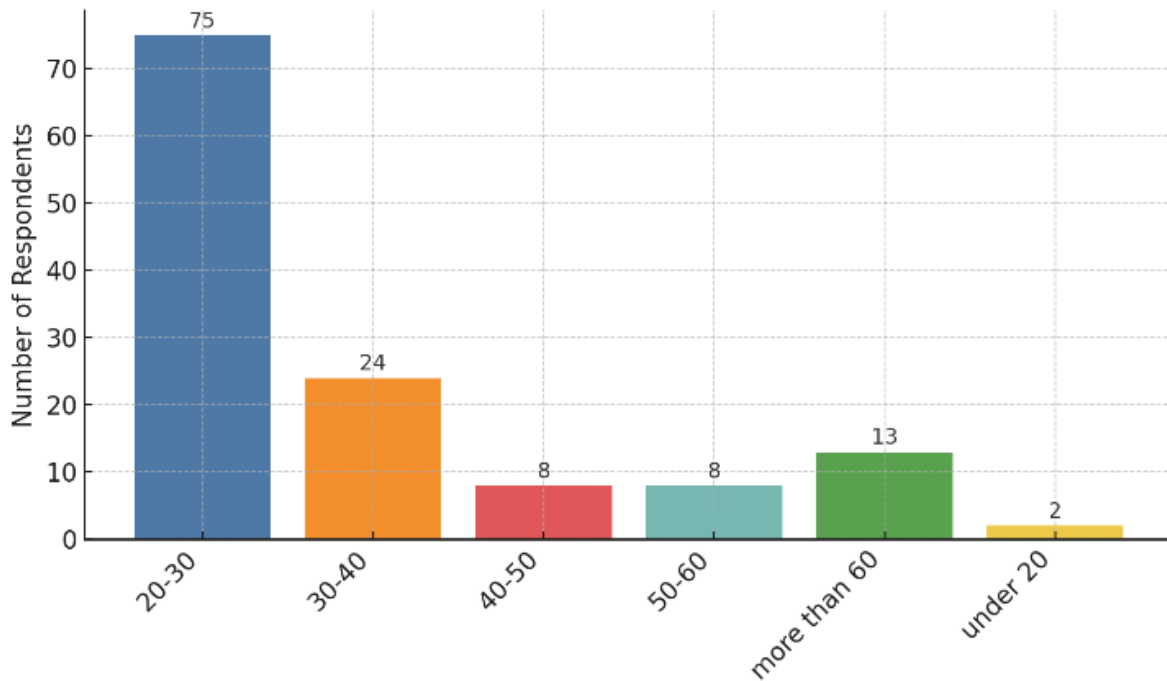


Figure 32: Chart of Age Distribution of Respondents

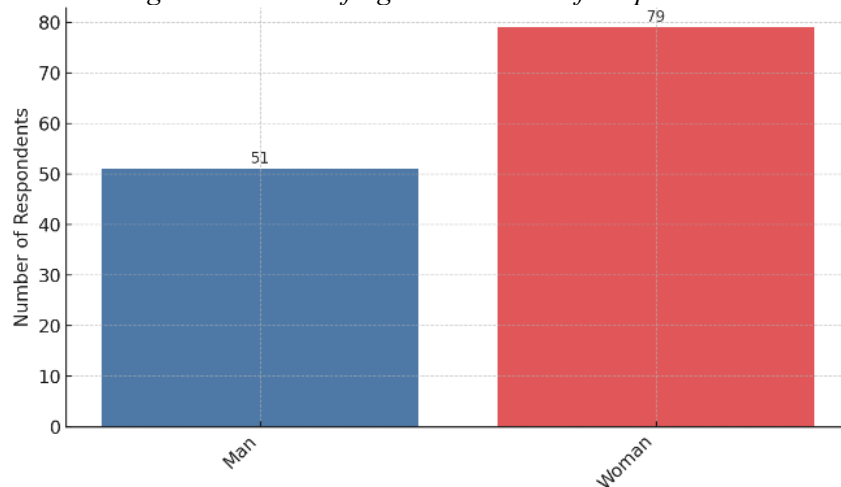


Figure 33: Chart of Gender Distribution of Respondents

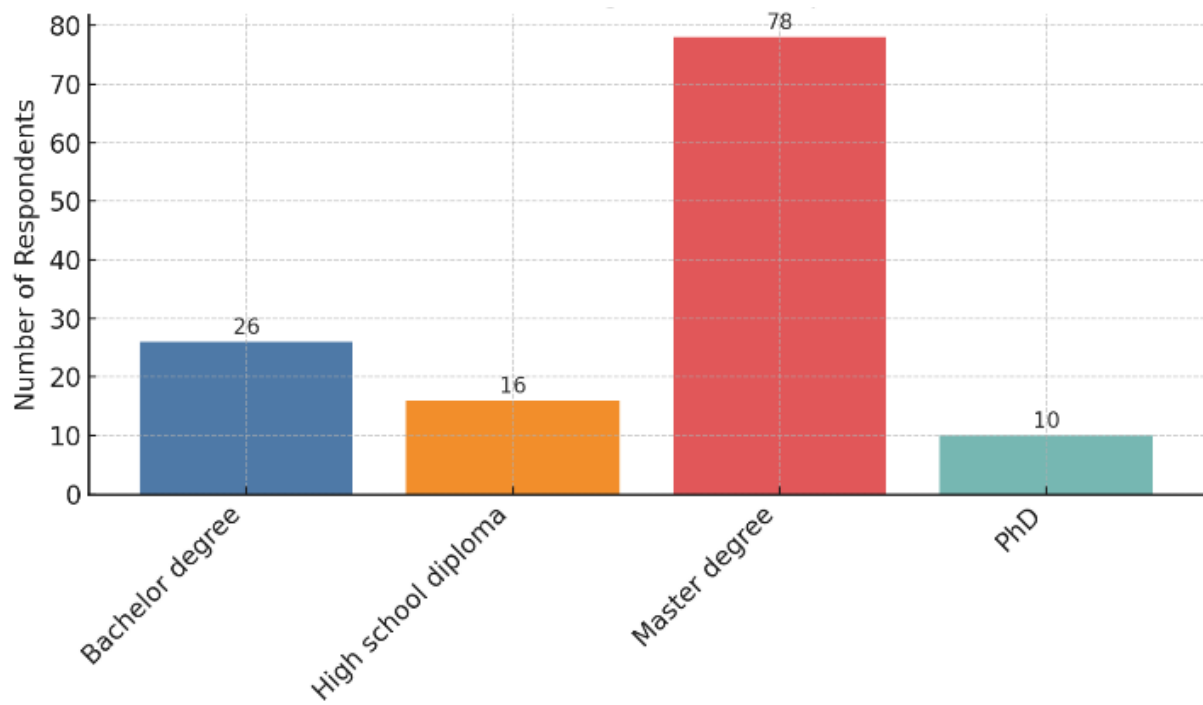


Figure 34: Chart of Educational Background of Respondents

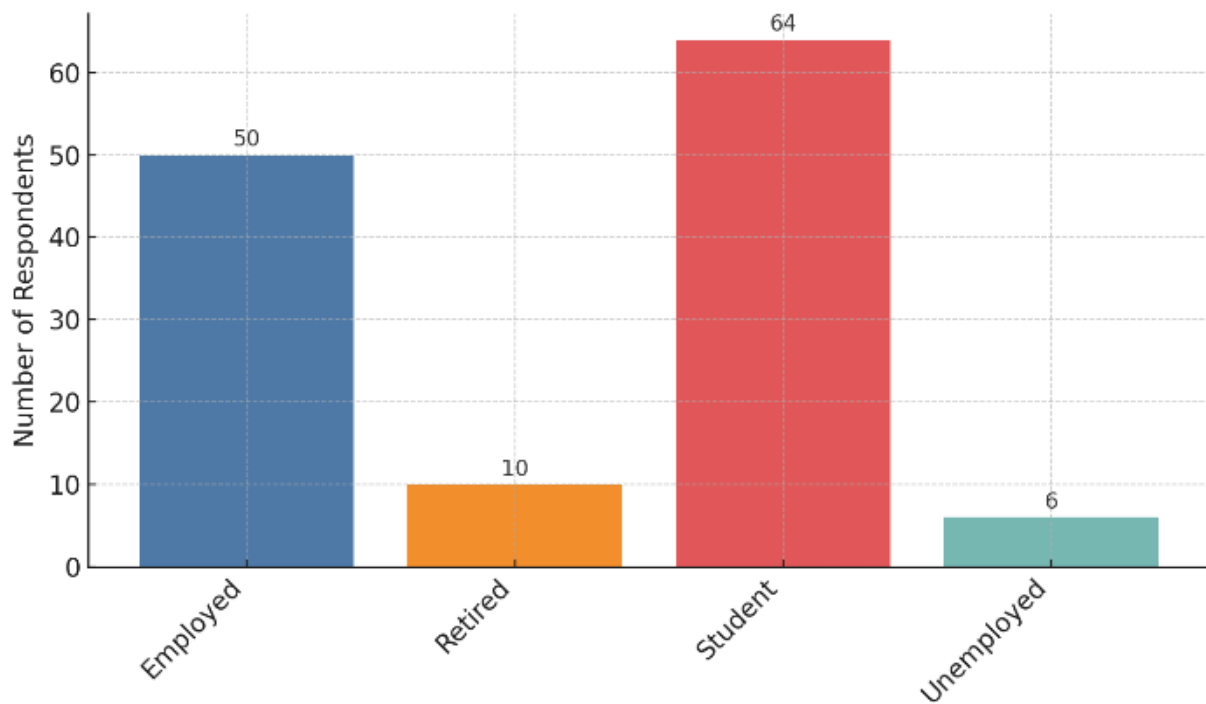


Figure 35: Chart of Occupation of Respondents

5.2.2. Bridging and Bonding

This part explores the connection between participation frequency in NbS activities among individuals with varied backgrounds (Q21) and three categories: a sense of connectedness to larger communities (Q22), effectiveness of NbS in promoting social interaction (Q23), and their impact on emotional well-being (Q24). A cross-tabular analysis of these questions shows how real participation levels influence attitudes towards inclusion and well-being in NbS areas.

(Fig. 36) The 'Often' respondents who answered (Q21) about participating in NbS with other groups were six in total, and out of those, three reported 'Very much' feeling connected to individuals who were not from their social circles (Q22), two answered 'Moderately', and one answered 'Slightly'. From those who answered 'Sometimes' participation (29), 17 answered 'Very much', 9 'Moderately', and 3 'Slightly'. Interestingly enough, from those who 'Rarely' participated (28), 10 answered 'Very much', 13 'Moderately', and 5 'Slightly'. And even from those 67 who 'Never' participated, a considerable number—32—reported NbS helped them be 'Very much' connected, 26 answered 'Moderately', and 9 'Slightly'.

This indicates that a sense of being connected is by no means reliant on regular face-to-face contact. Passive NbS space use—or perception of NbS spaces by citizens—can even result in a sense of being included. High participation is however also related to stronger feelings of connection, affirming the strength of ongoing participation in developing bridging and bonding effects.

(Fig. 37) On perceived social interaction (Q21 vs Q23), it is also positive but less directly related. Out of 6 'Often' respondents, 4 considered NbS 'Very effective' in increasing social interaction and 2 rated them 'Somewhat effective'. Out of the 29 'Sometimes' respondents, 15 chose 'Very effective', 11 'Somewhat effective', and 3 were 'Neutral'. Out of the 'Rarely' group (28 people), 15 continued to rate NbS 'Very effective', 9 'Somewhat effective', and 4 were 'Neutral'. The remaining 67 'Never' respondents also showed a 'Slightly' different pattern: 19 were 'Very effective', 34 'Somewhat effective', 11 'Neutral', and 3 were 'Ineffective'.

This pattern supports how continued participation in NbS initiatives reinforces their significance in enhancing social interaction. And it is notable to recognize even non-active participation is viewed as socially positive demonstrating the wider social worth that NbS projects have beyond active users.

(Fig. 38) The final comparison (Q21 vs Q24) is in respect to the wellbeing dimension of emotions and mentality. While 4 out of 6 regular participants reported NbS having a 'Strong influence' on their wellbeing and 2 reported a 'Considerable influence', amongst those who took part 'Sometimes', 16 out of 29 opted for 'Strong influence', 10 reported 'Considerable', and 3 reported 'Little influence'. The 'Rarely' group also followed in similar distributions: there were 13 reporting 'Strong influence', 11 'Considerable', and 4 'Little influence'. For the other group of non-participants with the same total number (67), 21 reported a 'Strong influence', 26 reported 'Considerable', 16 reported 'Little influence'.

This evidence supports the proposal that multi-group NbS participation levels as low as zero are not a bar to an experience of these areas raising emotional well-being. Percentage of respondents who feel strongly influenced increases steadily with increasing participation frequency, supporting the significance of participation to the individual, emotional value of activity.

Implications and Interpretation

The questionnaire results show a positive relationship between frequency of participation and self-claimed emotional and social gains among NbS activity respondents. Interestingly, while respondents are non-users, there seems to have been good positive sentiment towards NbS, and potentially good value production occurring on a sustainable community basis. As with Kabisch et al. (2016) and Peters et al. (2010), who lay out urban green spaces as able to create well-being and cohesion despite passive, or secondary, use, this is consistent.

The high percentage of 'Never' among the answer to participation reveals a necessity to increase inclusiveness and low-threshold measures to enhance accessibility. As both reports emphasize, culture-aware projects properly promoted and centered on community activity - like group-based or cross-community projects - can attract wider participation and enhance place attachment. Measures of this kind are the key to unlocking NbS' full social value and to ensure equal access to their benefits among various urban populations.

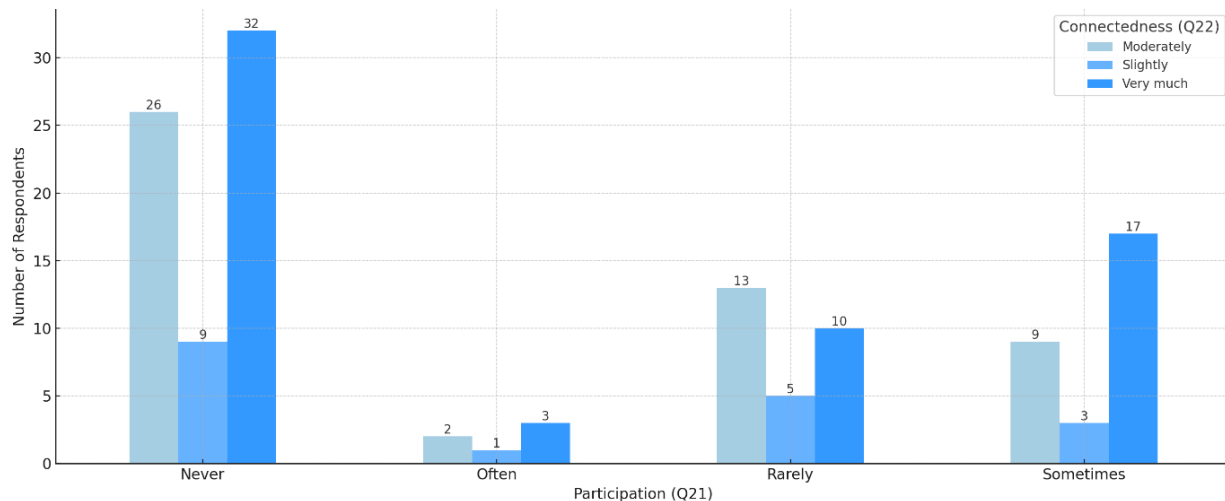


Figure 36: Cross-Tabular Analysis of Participation vs Feeling Connected

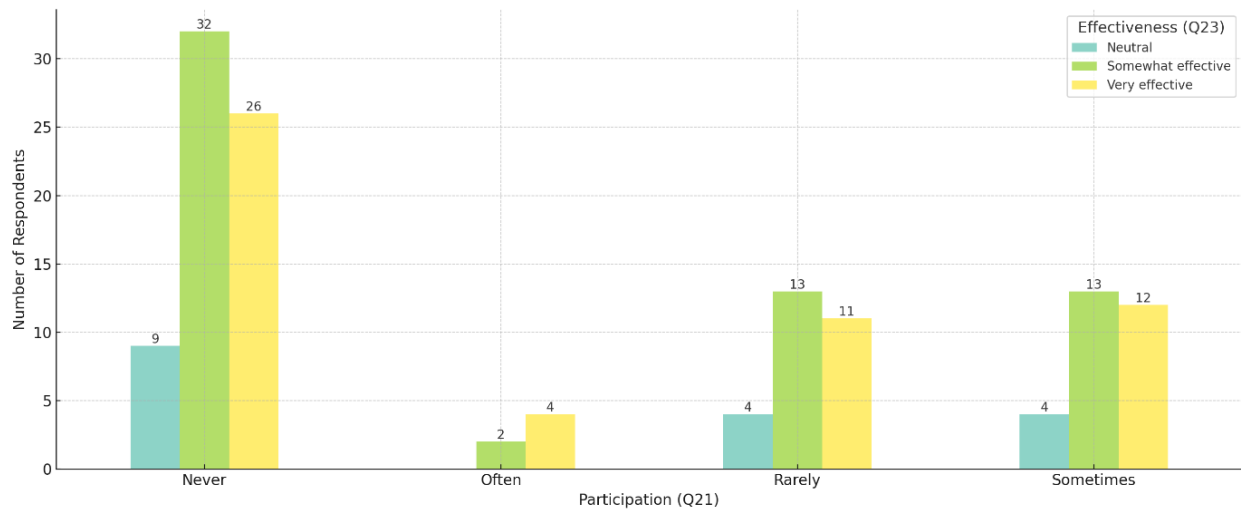


Figure 37: Cross-Tabular Analysis of Participation vs Social Interaction

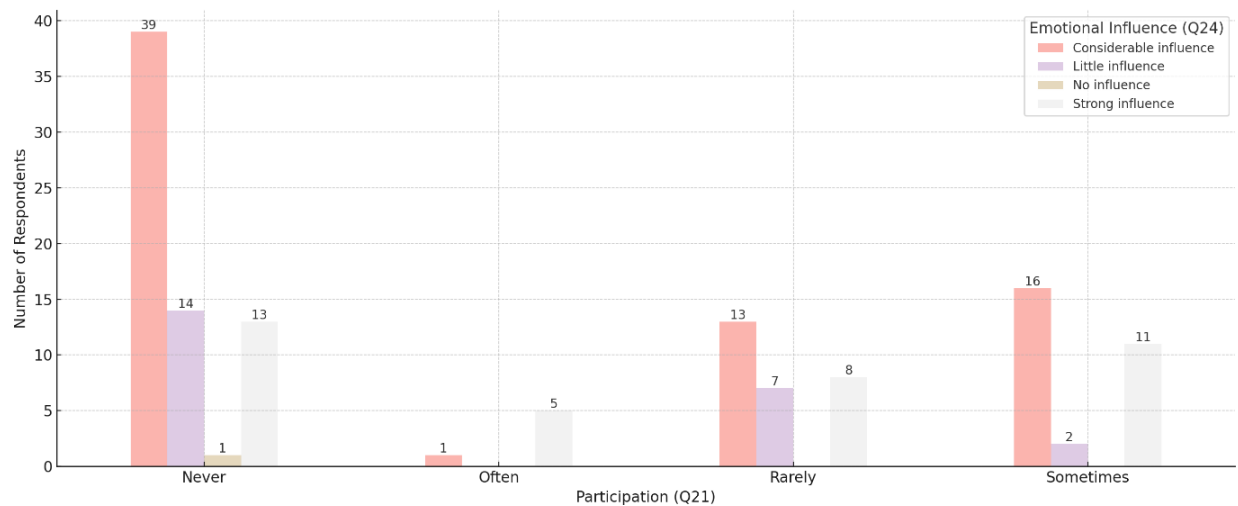


Figure 38: Cross-Tabular Analysis of Participation vs Emotional Well-being

5.2.3. Estimated Morbidity and Mortality

For assessing whether various categories of Nature-based Solution (NbS) engagement are linked to perceived benefits in terms of their physical and/or mental well-being, two cross-tabulations were prepared: Q31 and Q32, and Q31 and Q33. These visualizations explore whether or not individuals engaging in single NbS projects report better contributions toward their physical and/or mental well-being.

(Fig. 39) The initial chart shows us that activity with “Orti generali” is highly correlated with positive attitudes towards physical health gains. Out of a total of 17 respondents who said they participate in “Orti generali”, 10 reported that NbS have “a lot” to contribute to their physical health, and 6 reported “a little.” Only one in this category was neutral or didn’t answer. Other

initiatives, like “Green walls in Mirafiori” and “Valdocco vivibile”, were also positively connected but engaged fewer people—preventing comparative potency.

Surprisingly, while among the 74 respondents who mentioned none of the engagements (coded as “No”), most of them saw some degree of benefit: 28 answered “a lot” and 40 chose “a little.” This indicates that even people who are not involved with particular NbS initiatives in a concrete manner might still acknowledge overall benefits related to green infrastructure in their environment. But the percentage of high-impact responses is clearly larger in people involved in a particular site, notably “Orti generali”.

(Fig. 40) The pattern is also replicated for mental wellbeing in the second chart. For those associated with “Orti generali”, 13 said NbS “a lot” contributes to their wellbeing and 4 chose “a little.” For “Green walls in Mirafiori”, 3 in every 4 respondents answered “a lot”, supporting the perceived value of green vertical cover in terms of psychological wellbeing. For the group with unspecified participation again there were varied but predominantly positive responses: 37 answered “a lot”, 28 answered “a little,” and 9 were “neutral”.

Most striking is how much greater the percentage of “a lot” responses is for people who experience named, physical projects. This reinforces how critical face-to-face spatial and sensory contact is in affecting mental wellbeing perception. On average, individuals who go to, walk past, or take part in NbS schemes are able to access psychological gains more reliably than those who simply reside near them or are aware of them.

Implications and Interpretation

These results indicate that simply experiencing urban nature passively has some benefits to human health, but active engagement in well-organized NbS interventions - e.g., Orti Generali or the Mirafiori's Green Walls - is better linked with perceived physical and mental health benefits. This corresponds to Kabisch et al. (2016), who highlight the fact that systematic and programmatic participation in NbS maximizes their related benefits for physical and psychological well-being through enhanced physical activity and obesity reduction, decreased respiratory diseases, and enhanced psychological well-being. The research also points out the necessity of making NbS inclusive, accessible, and well-maintained so they will be used repeatedly and translate into long-term public well-being.

Additionally, Hartig et al. (2014) provide robust evidence of green space proximity and exposure and reduced morbidity and mortality and identify stress reduction, social cohesion, and increased physical activity as key mediators. They support the assumption according to which diffuse exposure from green space has beneficial effects but more extensive and dense exposure - particularly in the form of local initiatives - results in stronger and more equitable benefits for health.

These findings reinforce the argument that urban planners must go beyond simply constructing green areas. To achieve measurable health benefits, cities must actively promote participation and awareness, especially for lesser-known or underutilized NbS. Ensuring programmatic maintenance

and encouraging use by diverse social groups are essential steps toward distributing health benefits more equitably across the urban population.

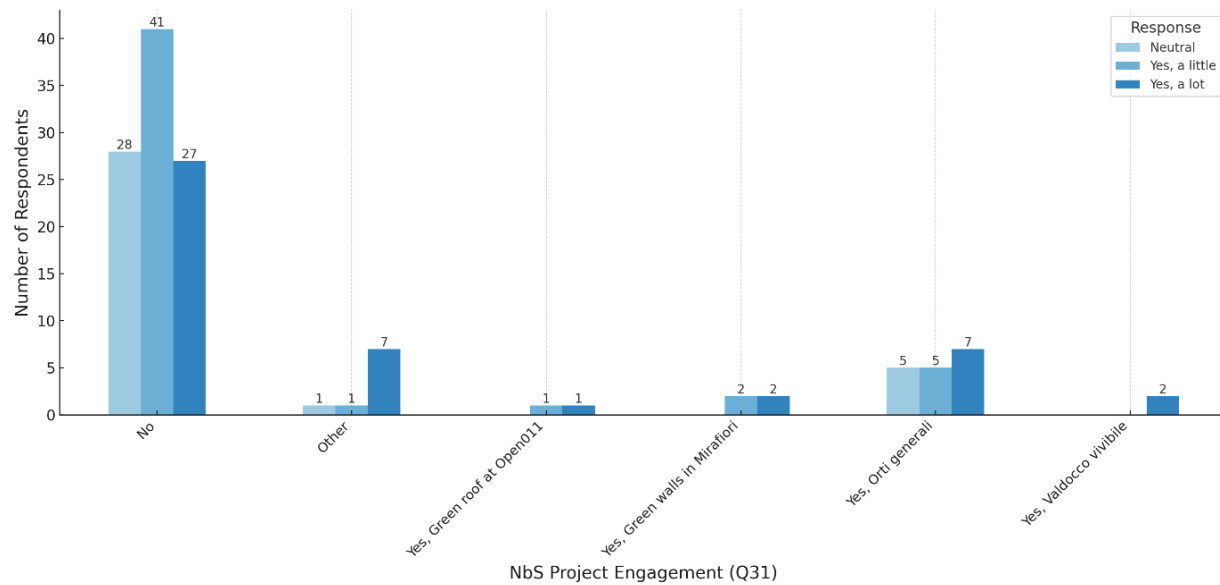


Figure 39: Cross-Tabular Analysis of NbS Engagement vs Physical well-being

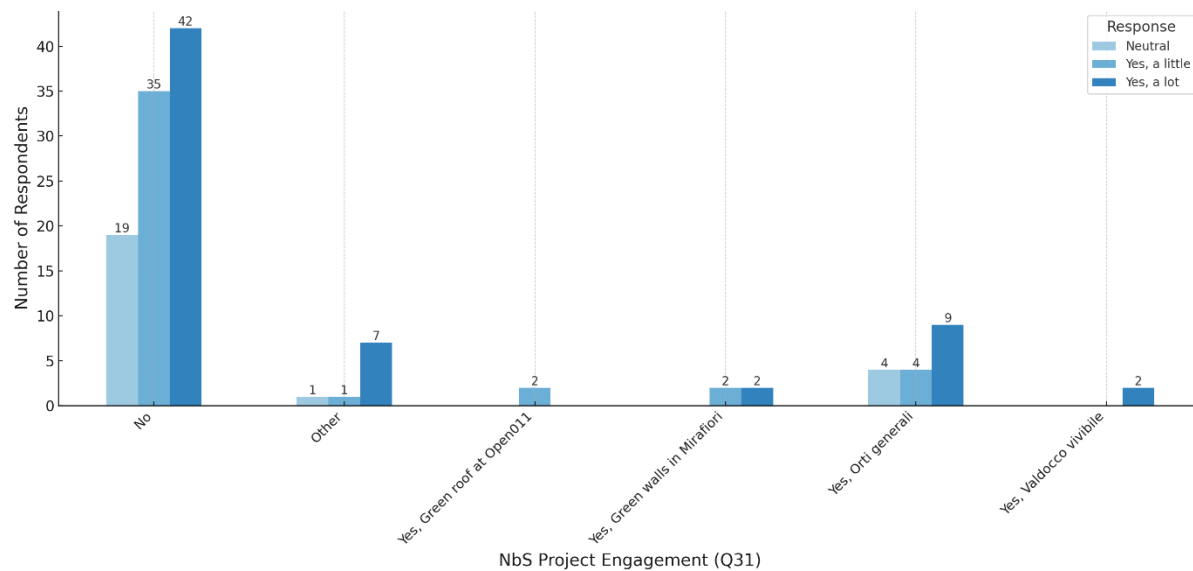


Figure 40: Cross-Tabular Analysis of NbS Engagement vs Mental well-being

5.2.4. Citizen involvement in environmental education activities

For an understanding of impact of environmental education on behavior change, the cross-tabular analysis between participation rate and specific project activity and reported behavior and attitude changes has been used here. The results from Questions 14, 15, 16, and 17 show the effect of both participation intensity and nature on outcome.

(Fig. 41) The compares frequency of participation in environmental education with degree of behavioral change. The outcome shows a very strong correlation: those who participated 'often' reported the highest degree of behavioral change. Out of a total of 16 people in this category, 13 reported 'Significant changes' and 3 reported 'Minimal changes.' None reported 'neutral' or 'no change,' implying a very good educational experience when frequency is high.

For those who 'participated 'sometimes' (39 respondents), there were more varied changes in behavior. 12 noticed 'significant changes', 13 noticed 'minimal changes', and 12 were 'neutral'. For those in the 'rarely' group (35 respondents), 15 were 'neutral', 14 reported 'minimal changes', and only 5 noticed 'significant changes'.

The strongest contrast is between the (40 respondents) who 'never' engaged. Here, most (20) were 'neutral', and 12 said 'no change'. Just 5 reported 'significant change'. These results show a clear pattern: more frequency of participation is strongly linked to more behavioral change, highlighting repeated and/or regular contact with environmental education.

(Fig. 42) The second graph examines what type of NbS activity people participated in and how it affected their reported behaviour change. Out of the 20 respondents involved in environmental education activities in Orti generali, 7 reported a notable change, 10 a minor change, and just 2 were neutral. This supports Orti generali as a clear success in terms of a site of high participation, but also in driving environmental learning and change.

Involvement in other individual NbS projects was less regular but equally useful. "Valdocco vivibile" received 6 replies, with 2 of these stating "minimal change" and 1 "neutral". Green rooftop at "Open011 hostel" and "Green walls in Mirafiori" only received a handful of replies, with most stating "neutral" or "no change", possibly because of small population samples.

The "Other" category also demonstrated positive results: 4 of its 7 responses reported "significant changes", demonstrating even non-mainstream or localized projects are capable of strong educational influence. By comparison, most respondents noting no particular project participation (74) were most likely to respond with less change: 24 "significant", 21 "minimal", 41 "neutral", and 14 "no change".

This comparison supports the conclusion that education conducted around concrete, observable NbS projects is more effective than generic or non-generic experience. Place-based learning, in a well-known neighborhood setting in particular, enhanced retention and also environmental attitude transformation.

(Fig. 43) A deeper insight is gained by considering the frequency of participation in environmental education activities and associated NbS projects (analysis of mixed Q15–Q16). Excluding nonparticipants, the survey reveals that people who took part more frequently tended to be associated with several NbS initiatives. The most frequently associated NbS initiatives were “Orti generali”, “Valdocco vivibile”, “Green roof at Open011”, and “Green walls in Mirafiori” for people who went to activities “many times” or “once a month”. These are headed by “Orti generali” in terms of mentions. This extra visibility and participation in “Orti generali” can be partially accounted for by the particular context of survey respondents: several master students had seen “Orti generali” on a first-semester course-organized site visit. Therefore, “Orti generali's” visibility in these data might be a reflection of both organized public interest and curricular structuring in education. This structured contact has nonetheless apparently been successful in generating awareness and perhaps even prompting additional voluntary participation.

The combined analysis of Q15–Q16 emphasizes that more regular respondents generally have wider exposure through various NbS projects. People who responded “once a month” or more were most likely to cite two or more sites, indicating repeated or ongoing participation promotes greater familiarity and attachment to several types of urban nature interventions. This shows the range of NbS provision - from gardens to green roofs to green walls - allows for varied entry routes to connect citizens through environmental education.

Implications and Interpretation

The results of this section also show a very strong relationship between environmental education activity participation and positive environmental behavior and consciousness changes. Respondents who took part most often in activities like Orti Generali were also more likely to refer to an improved respect for urban nature and developed ecological practices. This confirms that environmental education integrated in Nature-based Solutions (NbS) not only serves a positive function but that it is imperative in developing long-term environmental responsibility in citizens.

One clear instance of this is Orti Generali, an initiative which has achieved high visibility amongst young inhabitants and students in Turin. As I am a postgraduate, I posted on our platform when I learned of this initiative in my first semester during lectures and academic conversations. This preliminary awareness is an indication of the manner formal and casual learning trajectories are always determining factors when rising awareness levels are an issue. In fact, numerous fellow peers of mine are also familiar with Orti Generali, which indicates the way in which institutional educational spaces tend to be instrumental in multiplying levels of reach and effect for local NbS initiatives. This affirms the function whereby awareness - and thus participation - tends to initiate through exposure via educational spaces.

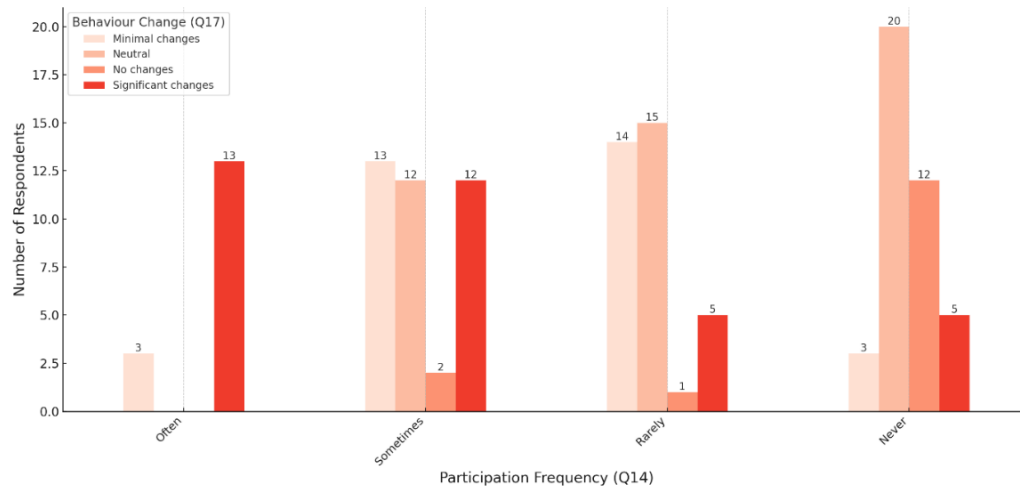


Figure 41: Cross-Tabular Analysis of Educational Participation vs Behaviour Change

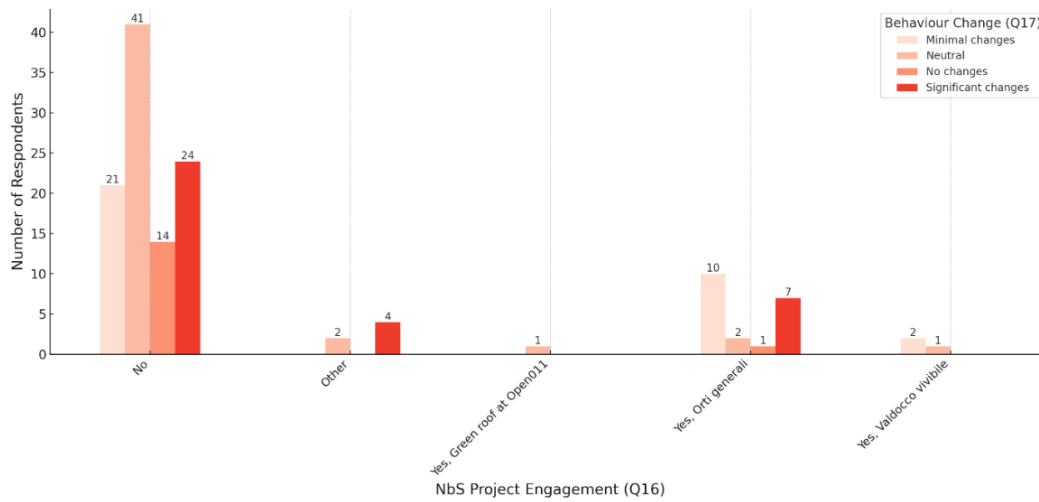


Figure 42: Cross-Tabular Analysis of NbS Projects vs Behaviour Change

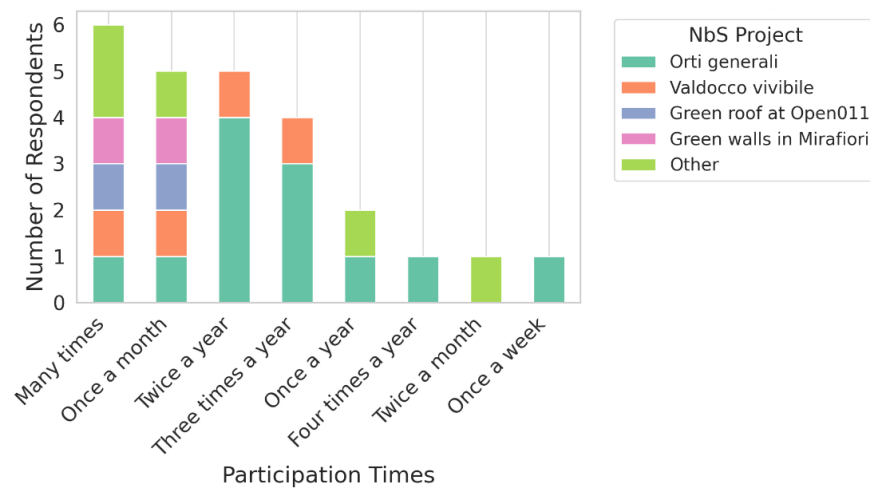


Figure 43: Cross-Tabular Analysis of NbS Projects vs Participation Times

5.2.5. Perceived Quality of Urban Spaces

In order to determine the effect of interaction with certain Nature-based Solutions (NbS) on citizens' perception of the quality of urban space, the three essential dimensions were considered: aesthetic quality (Q26), safety (Q28), and emotional attachment (Q30). These were cross-tabulated against Q25, where participants identified certain NbS projects that they participate in or notice in the course of their daily interactions.

(Fig. 44) The initial comparison indicates an evident relationship between actual interaction with targeted NbS interventions and greater aesthetic appreciation. Of the 22 who cited Orti generali, 10 marked it as “Very appealing”, and 10 as “Appealing”. The same held true for the group who interacted with “Green walls in Mirafiori” or “Valdocco vivibile”, although to smaller degrees.

Interestingly, even the respondents who reported “No” interaction with any one of the NbS projects still had positive visual feelings: 29 chose “Very appealing” and 40 chose “Appealing”. This indicates that mere passive exposure to NbS or overall awareness does have the potential to lead to positive visual appreciation, though the level of highly favorable ratings happens to be higher with active interaction.

This trend supports the idea that NbS can transform perceptions of urban aesthetics, especially when they are experienced up close and frequently.

(Fig. 45) Safety is one of the core features of urban quality, and the results indicate that residents who are involved with visible, accessible NbS interventions perceive themselves to be safer in such places. For instance, 11 of the respondents who cited Orti generali answered “Safe”, and 6 answered “Very safe”. While among the Valdocco vivibile group, 4 answered “Safe” and 2 answered “Very safe”.

In the case of the “No” group, on the other hand, the responses were more guarded: while 38 registered “Safe”, 24 registered “Neutral” and 5 registered “Unsafe”. This finding corroborates the significance of visual familiarity and green space visibility in the formation of attitudes of public safety.

This concurs with urban design studies, whereby research indicates improved green space integration leads to increased passive surveillance, social visibility, and community comfort, and hence creates a safer environment.

(Fig. 46) The last chart indicates the level of engagement with NbS is highly related to emotional attachment to the urban space. Of the people who noted Orti generali, 5 were “Very attached” and 11 were “Attached”. Respondents who identified Valdocco vivibile and Green walls at Mirafiori also had high emotional attachment rates, but in smaller numbers.

The “No” engagement group, though still somewhat attached (19 “Attached”), tended predominantly towards “Neutral” (33 respondents) or “Not attached” (7), and indicated the detached city life.

This corroborates theories of place attachment, where interaction with the space, familiarity of the body with the space, and sense of value of place all contribute to emotional attachment. It verifies that NbS not only can serve as environmental infrastructure but also as social and emotive anchors within the cityscape.

Implications and Interpretation

The findings validate the significant contribution made by Nature-based Solutions (NbS) in increasing the perceived quality of urban areas - particularly in terms of aesthetics, safety, and emotional appeal. The highest positive feedback ratings went to locations such as Orti Generali and Valdocco Vivibile and were also the areas where respondents used their spaces the most.

Notably, those with minimal engagement still showed improvements in visual quality and feelings of comfort. This is consistent with Kothencz et al.'s work (2017), where perceived recreation capacity and perceived scenery are both strong predictors of perceived satisfaction and quality of life. These improvements highlight the ability of well-designed green infrastructure to make both active and passive contributions to the quality of life in the city.

Further, enhanced emotional bonding correlated with high and frequent use of green areas and substantiated the work by Wang et al. (2024), where richness and openness in environments enhanced user experience and fostered additional place attachment.

These are especially important to policymakers and city planners in their focus on creating NbS that are ecologically successful yet emotionally engaging and attractive as well. Placing importance in aesthetics, comfortability, and usability can bring the greatest degree of public approval and make NbS a significant contributor to livability and satisfaction in the city.

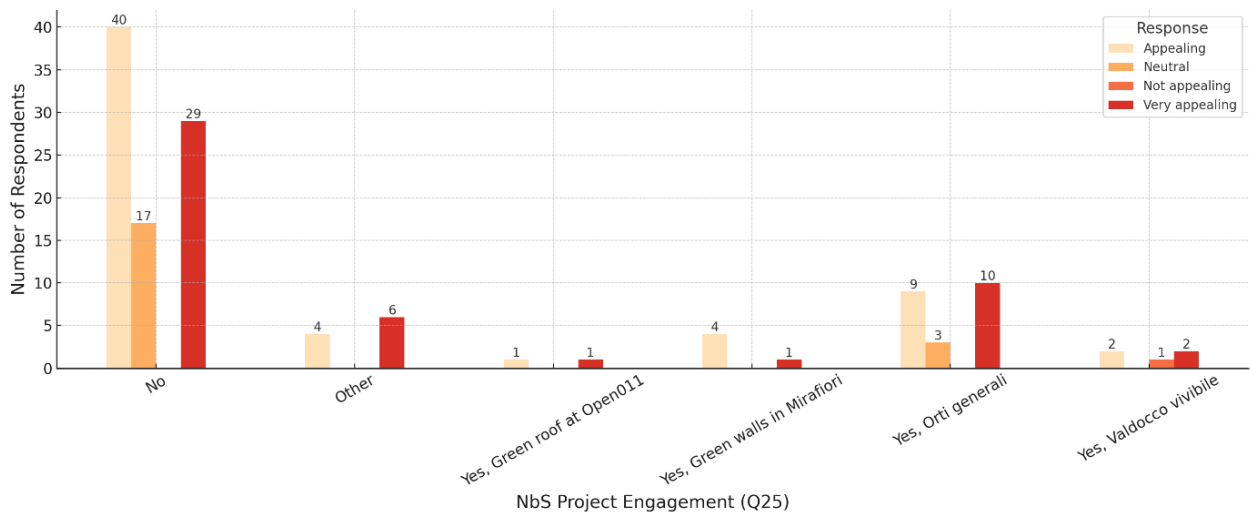


Figure 44: Cross-Tabular Analysis of NbS Engagement vs Aesthetic Appeal



Figure 45: Cross-Tabular Analysis of NbS Engagement vs Perceived Safety

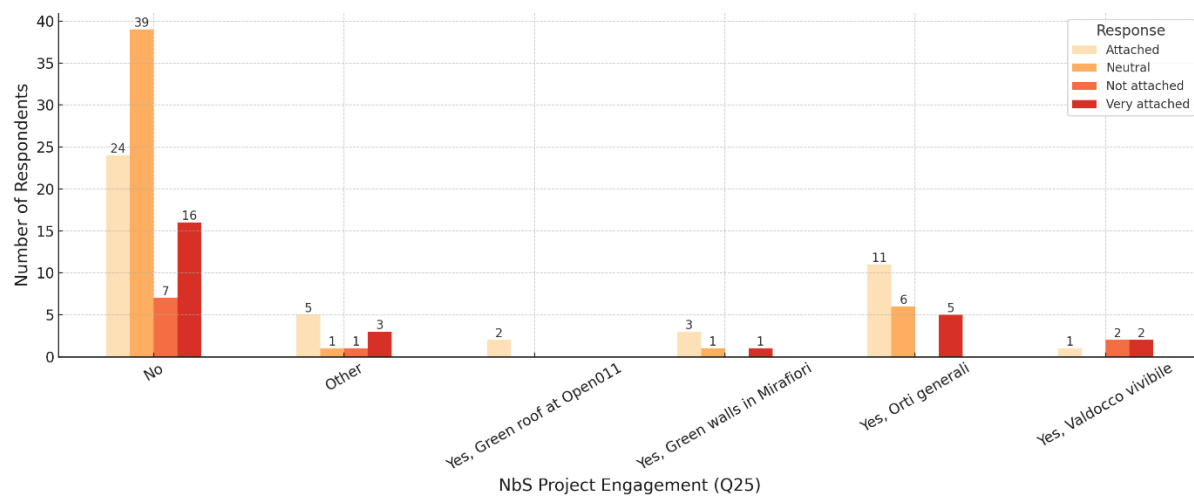


Figure 46: Cross-Tabular Analysis of NbS Engagement vs Emotional Attachment

5.2.6. Proportion of Citizens involved in participatory processes

Survey answers analyzed for engagement in Nature-based Solutions activities identify significant trends in both frequency and depth of engagement at the civic level. For Q10, participants were asked if they have ever been involved in community-related NbS activities, followed by complementary questions Q11 and Q12 measuring how many and how often.

(Fig. 47) The cross-tabulating of Q10 and Q11 shows bifurcation in the behavior of the participants. Those participants who chose to say "Yes, once" strongly indicated only one-time engagement annually (n=5), toward an infrequent, event-based model of engagement. Those participants are likely attracted to one-per-year events or one-shot opportunities, with low levels of repetition in engagement. In comparison, the group that chose to say "Yes, multiple times" showed much greater heterogeneity in frequency of engagement. This group said they participated

from twice-per-year to weekly, with some reporting ten-or-more-per-year engagement. This heterogeneity within this group highlights the central segment of very active participants, who are much more integrated into the frequent life cycle of NbS projects.

(Fig. 48) This is reflected in the comparison of Q10 and Q12, where they analyzed the frequency of participation as stated. Following recoding of answers (e.g., categorizing “Between 2 and 4 times a year” under “Yearly”) and removal of “Not applicable” answers, the data reflect the bifurcation seen in Q11. Of the participants recalling each one of the last seven years, most were linked to single-year frequency (n=7), while repeat participants were dispersed, with maximum frequencies in the seasonal (n=7) and yearly (n=4) frequencies. This suggests one-time participants prefer to typically attend each year, while repeat participants integrate their activity more regularly into the year's cycle.

These results identify a dual-level model of civic engagement in NbS: a larger group of intermittent participants, and a smaller group of interested repeat contributors. Implications are profound for participatory planning and community-driven environmental decision-making. Interventions to build depth of engagement must attend to facilitating accessible points of entry for newcomers while offering progressive pathways of engagement - such as volunteer opportunities, stewardship for projects, or roles at the community leadership level - or already engaged participants looking to contribute regularly.

(Fig. 49) The analysis of Q10 vs Q13 also gives further insight into participatory behavior and examines whether participation is correlated with specific NbS projects. To offer analytical clarity, the answers were classified in five thematic categories: Orti generali, Valdocco vivibile, Green roof at the Open011 hostel, Green walls in Mirafiori, and Other. This classification provided a structural framework through which the resulting distribution at the level of the projects could be understood.

The survey shows the highest salience location to be the one at Orti generali, and this is in the case of both the repeat participants (n=9) and the single participants (n=4). This salience further affirms the conclusion reached earlier about the initiative at Orti generali being successful, not just in attracting popular attention but also in causing repeated and habitual engagement. Its visible and accessible community-oriented model is responsible for its success in triggering habitual engagement.

In comparison, projects like Valdocco vivibile and Green walls in Mirafiori exhibited lower levels of engagement, with no more than one or two mentionings of participation. They might represent lower awareness, lower levels of project coverage, or fewer opportunities for public interactions. No mentions were initially noted for Green roof at the Open011 hostel. After re-examining imprecise responses coded under “Other,” however, two were re-classified as concerning this project - highlighting the value of thorough qualitative coding to pick up the full variety of citizens’ engagement with NbS.

The “Other” category, as less predominant, is still of analytical significance. It encompasses action with decentralized or informal NbS initiatives, such as university plots of land, cross-border experiences, or professional ventures. Following reallocation, the category still consisted of 4

participants who took part numerous times and 1 participant who took part once. This indicates that even if institutional projects have prominence in the formal discourse of NbS implementation, there is still much significant action taking place within less formal, less conspicuous settings.

Implications and Interpretation

The evidence demonstrates a two-tiered engagement pattern: a large number of periodic participants and a minority core of very active citizens. Although periodic engagement - such as yearly event attendance - is evidence of awareness in general, the consistent engagement by a minority indicates more than just exposure is needed for deeper civic engagement. These findings are consistent with research evidence requiring the already-engaged to participate in processes and noting the structural barriers remaining unresolved for others (Christensen, 2020).

Effective NbS governance therefore must complement outreach through deeper engagement channels. Arranging accessible entry points - in the form of public workshops or co-design meetings - in combination with leaders' roles or stewardship initiatives can promote sustainable engagement. The case of the Orti Generali, with their greater repeated engagement, illustrates the capacity of visibility and access to produce sustainable participation.

In order to achieve inclusive governance targets, the city needs to institutionalize co-creating processes and make participation more visible and accessible to marginalized groups. Participatory planning doesn't survive based solely on opportunity alone, but rather through intentional scaffolding that aids community capacity and extended cooperation (Fung, 2006; Royo et al., 2011).

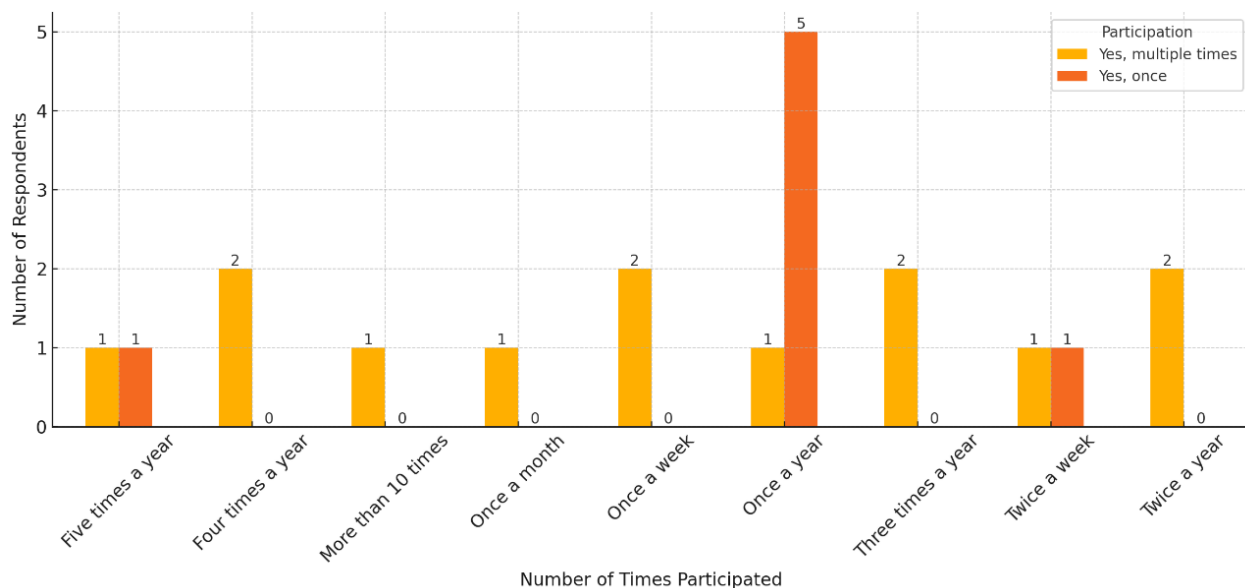


Figure 47: Cross-Tabular Analysis of Participation Frequency vs Yes Responses

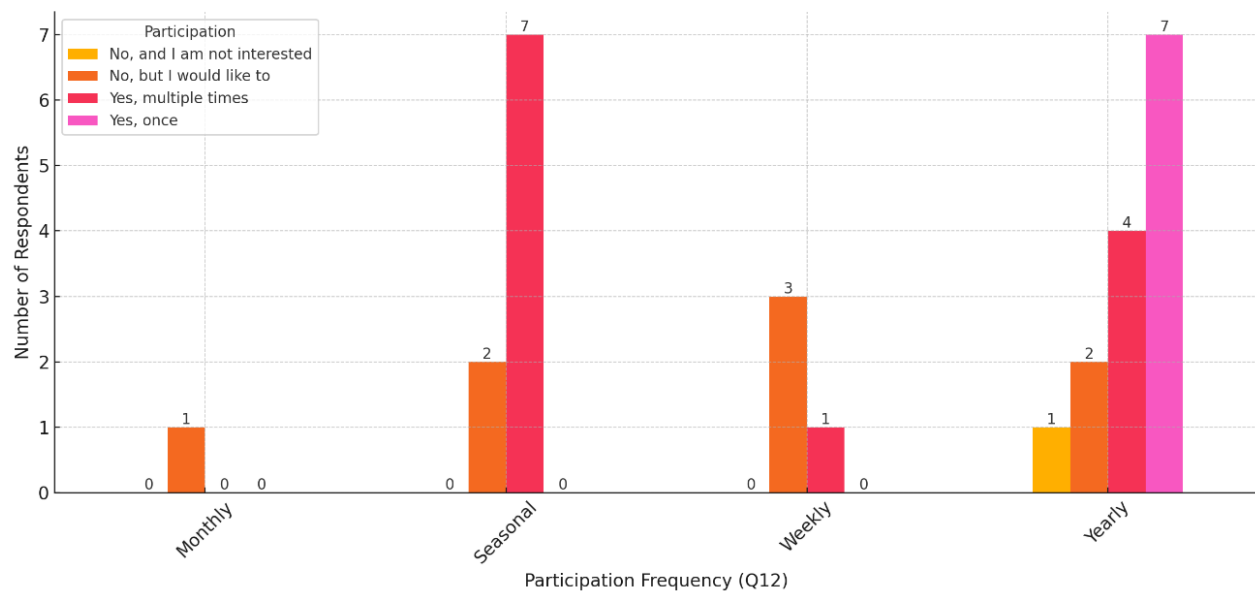


Figure 48: Cross-Tabular Analysis of Participation vs Activity Frequency

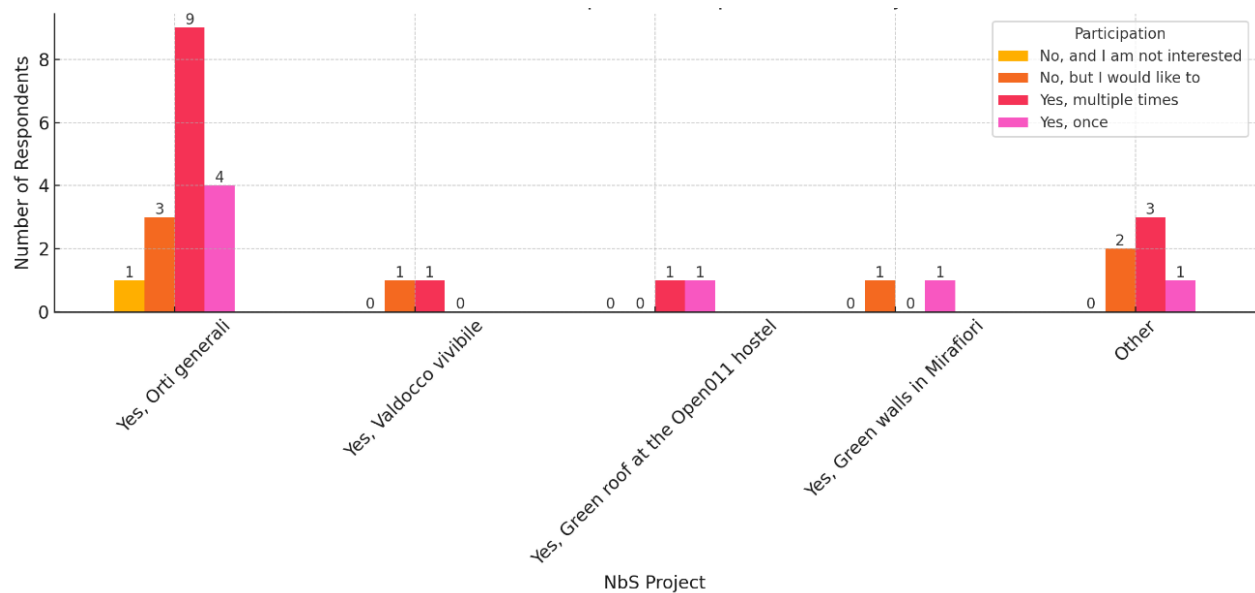


Figure 49: Cross-Tabular Analysis of participation vs NbS Projects

5.2.7. Proportion of Community who Volunteer and Engaged with Projects

The filtered graph of Q18 (Volunteering frequency) cross-linked to Q20 (When – specific NbS Project participation) gives us a keen insight into active volunteerism in Nature-based Solutions (NbS). By removing “Never” answers, the graph displays just those participants who mentioned at least intermittent engagement. The data shows very minimal reporting of volunteer work for NbS projects, and of the ones they did report, the frequency is sparse and dispersed amongst different types of projects. Few answers cluster in the "Sometimes" and "Rarely" groupings, and no entries are in the "Often" group, reflecting no intensive level of volunteering.

The most often cited of these sparse answers is “Yes, Orti generali”, which might indicate that the site might have provided easier or better-exposed volunteer chances. Some of the other projects, including “Valdocco vivibile”, “Green roof at the Open011 hostel”, and “Green walls in Mirafiori”, were merely mentioned in isolation. The “Other” field, existing as it does, probably accounts for informal, initiative-independent contributions, but is just as sparse.

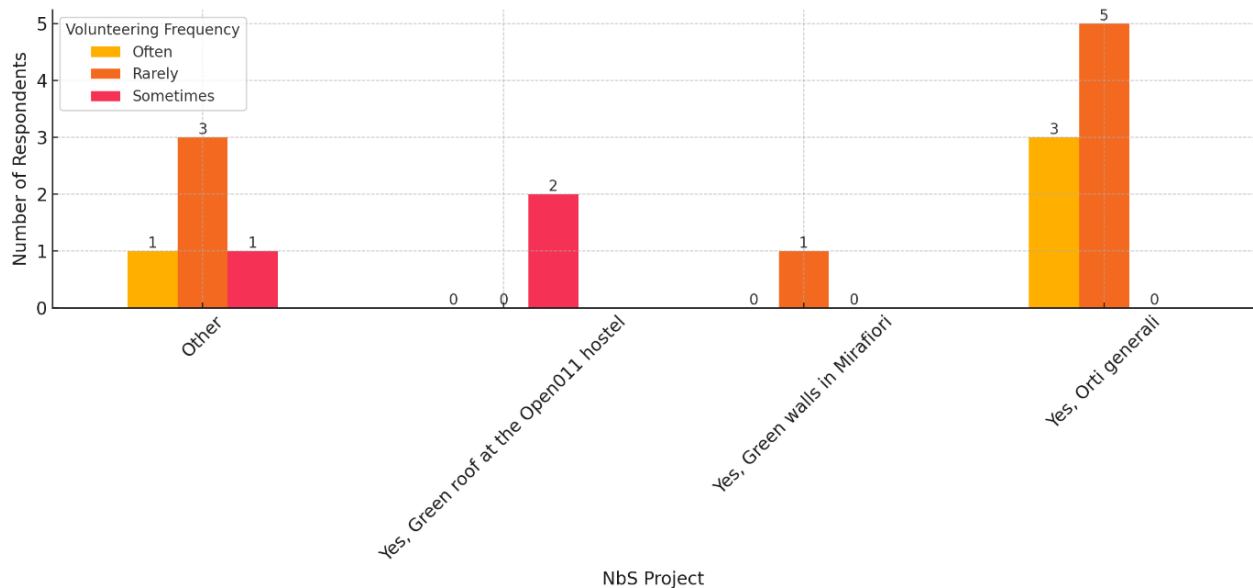


Figure 50: Cross-Tabular Analysis of Volunteering Frequency vs NbS Projects

Implications and Interpretation

The findings based on the cross-tabulation of Q18 and Q20 indicate minimal structured and regular volunteering in NbS projects amidst the availability of some community awareness and ad hoc event involvement. This demonstrates the reality that the public may verbally support NbS but are faced with barriers to participate in the institutionalized or long-term forms.

This is consistent with Snyder and Omoto (2008), who contend volunteering does not flourish automatically - it takes structured role definition, institutional backing, and significant opportunity aligned with personal motivation and social values. Engagements typically remain superficial when the structure for engagement is poorly communicated.

Furthermore, this trend highlights the importance of social capital to community-based green practices. Putnam (2000) argues that civic decline – unless balanced with active and representative mobilization – would undermine community ability to pay for civic amenities and services such as green infrastructure.

In order to respond to this deficit, NbS programs need to implement clear and open volunteer paths with diverse avenues of engagement - some providing occasional support and others providing ongoing stewardship. Working with civic institutions, educational institutions, and neighborhood organizations can similarly address the awareness–action deficit and make volunteering part of everyday city life.

Chapter 6

6. Conclusion

This study set out to address the dual challenges of urban inequality and weak evaluation measures in the application of Nature-Based Solutions (NbS), outlined in the problem formulation. By framing a research question that inquired into how NbS in the city of Turin can best be measured by a suite of inclusive, equity-oriented indicators, the thesis aimed to explore whether or not these interventions are contributing to social justice and inclusive city development. Through a systematic review of six social indicators - Citizen Participation in Environmental Education Activities, Perceived Quality of Urban Space, Proportion of People Involved in Participatory Mechanisms, Proportion of Community Members Who Volunteer and are Involved in the Project, Bridging and Bonding, and Estimated Morbidity and Mortality - the research presents empirical proof of the social effects of NbS in the city of Turin. The results demonstrate that NbS, if deliberately created and implemented with local context and community consideration, are able to increase environmental consciousness, create emotional and cultural linkages to urban areas, and provide inclusive spaces of civic engagement - thereby accomplishing the thesis goals and directly serving the mission of the GREEN-INC project.

Nature based Solutions (NbS) hold strong promise for creating more socially equitable and inclusive urban spaces. However, the experience in Turin reveals clear practical limitations. Although places like Orti Generali and Valdocco Vivibile are praised for their visual appeal, sense of safety, and emotional significance, public involvement overall tends to be inconsistent and, at times, superficial. Low levels of environmental education and volunteering reflect a deficiency in strategic outreach and a failure of opportunities for meaningful participation to be visibly apparent. This is not a Turin pattern - more a symptom of wider transitions in Europe. As noted by Dekker (2019), volunteering and civic participation are far more evident among Swedes and Dutch than among Southern European nations. This comparison cements the proposition that structural context as well as culture does play a role when one would like to activate individuals differently. Closing such gaps requires city planning to do more to embed participation in the normal lives of greater numbers of community participants.

Working with community groups and schools is a pragmatic and cost-effective way of enhancing participation and instilling an environmental consciousness. According to Kettunen et al. (2018), achieving the Sustainable Development Goals (SDGs) demands policy development but also bringing the population into contact with the challenges and initiating networks that inculcate sustainability into everyday local life.

That said, the study still points to the clear social value of Nature-based Solutions. People who regularly spent time in green spaces consistently shared more positive views, especially when it came to their well-being and satisfaction with their community. These insights back up Bratman et al. (2015), who found that being immersed in nature can meaningfully improve both emotional health and mental clarity.

Furthermore, as supported by Frantzeskaki (2019), NbS co-created and embedded within a local urban setting enjoy greater public support and success in the long term. Aesthetics and safety perception are by no means superficial benefits but rather prerequisites for creating a sense of belonging and an incentive for repeated use.

To achieve the fully inclusive potential of NbS, planning needs to extend past infrastructure delivery alone. Planners need to promote a culture of engagement through measures involving social elements - education, access, and co-creation - in the very foundation of green infrastructure planning and delivery. Empowering all urban residents to engage with and benefit from NbS irrespective of current levels of engagement or social status contributes to creating more equitable and resilient cities.

Overall, the evidence highlights how NbS can be ecologically as well as a social inclusion and community resilience promoter- if backed by inclusive planning. Urban policymakers and practitioners are therefore urged to integrate social indicators into NbS assessment frameworks and to co-design interventions with local communities to increase broader participation and equitable outcomes. This will be the lock to unleashing NbS' full potential as catalysts of sustainable and inclusive urban transformation.

6.1. Key findings

This research sought to investigate how Nature-Based Solutions (NbS) integrated with Inclusive Climate Actions (ICAs) can contribute towards the promotion of social justice and inequalities in Turin. Based only on a survey-based method, four social indicators were considered. Major findings include:

- Citizen involvement in environmental education programs: Returns on questionnaires showed modest involvement, with some possibilities for increase through greater publicity and convenience.
- Perceived quality of urban spaces: Participants in areas with ongoing NbS interventions were more content with public spaces, relating green infrastructure to improved urban quality of life.
- Citizen participation in decision-making: The evidence illustrated limited participation, necessitating wider and more diverse participatory processes.
- Community participation and volunteering: In some regions, particularly where NbS are more evident, there was more community participation and volunteerism, suggesting more social cohesion.

Cumulatively, the survey results confirm that NbS can make a contribution towards increasing urban social equity. Differences in awareness and access do, however, emphasize the necessity of incorporating Inclusive Climate Actions in every stage of NbS planning and implementation.

6.2. Limitations

One of the main challenges during data collection was the low participation from people aged 40 and over, many of whom were hesitant to take part in the survey. Because of this, older age groups were underrepresented, which likely affected how inclusive and diverse the responses were making it harder to fully capture their perspectives. On top of that, overall involvement in nature-based solution (NbS) initiatives was fairly limited, especially when it came to community participation and volunteering. This lower level of civic engagement may have weakened the quality of data related to how communities were involved and how they perceived the social value of these interventions.

Six social indicators were evaluated within this thesis: citizen engagement with environmental education programs, subjective urban space quality, fraction of engaged citizens in participatory processes, fraction of volunteers who participate and work on projects, bridging and bonding, and estimated morbidity and mortality.

These indicators yielded rich insights into the social effects of NbS within Turin. Nevertheless, due to limitations on the availability of data and methodological feasibility, other important social indicators within the larger evaluation context- which comprised the measures of accessibility of urban green and blue spaces, land cover transition, and noise pollution exposure were not evaluated within this research. These indicators are key components of urban health and environmental justice that are worth examining further. These measures should be incorporated into future research to develop a more complete picture of the efficacy and equity outcomes of NbS.

6.3. Future Research Development

Developing upon the limitations recognized, research on Nature-based Solutions (NbS) in urban environments such as Turin should pursue more comprehensive and inclusive data collection and selection of indicators in the future. Engaging more older age groups is needed to better capture the diversity of community views, particularly considering the rising relevance of age-friendly city planning. Special efforts through targeted outreach and other forms of data collection - e.g., interviews or assisted focus groups - might extend to reach those who are unlikely to respond through digital or street surveys.

In addition, future research should extend the range of social indicators considered to incorporate key measures such as access to green and blue spaces, land use transformation, and exposure to noise pollution, all being core to measuring ecosystem and health in the city and addressing the emphasis placed on them in modern European policy documents. The use of quantitative assessment and geospatial measures could assist in the measurement of the indicators and their relationships with demographic parameters.

Moreover, longitudinal study designs and mixed-method designs can more accurately measure the social effects over the long term of NbS interventions, particularly increased community engagement, behavioral change and perceived well-being. They would also enable comparative research between cities or areas and put findings in context, thereby adding to an enhanced evidence-base to support policymaking.

Finally, future research needs to investigate ways in which co-creation processes and models of participation can be institutionalized within NbS planning. Learning more about the conditions enabling sustainable civic engagement and especially the engagement of marginalized or otherwise under-represented groups is a continuing research imperative to ensure NbS realize their potential as transformative and equitable city interventions.

6.4. Recommendations

This section ensures that the research outcomes are translated into implementable recommendations for urban designers, city authorities, and community-based organizations that aim to optimize the social value of Nature-based Solutions (NbS). The outcomes reveal that NbS which are well-designed, conspicuous, and functional can contribute considerably toward urban well-being, participation, education, and public space quality.

6.4.1. Expand Opportunities for Participation in NbS

What the findings reveal: Involvement - even intermittent - correlates with greater emotional well-being, more robust social connections, and more favorable judgments of public spaces. Many, however, remain at the periphery, engaging seldom or not at all.

- Create NbS programs offering low-barrier, inclusive points of entry (e.g., open events, relaxed workshops, public talks).
- Targeted outreach to bring in new users and underrepresented groups.
- Provide flexible work with the option to join in sporadically or even on a regular basis.

6.4.2. Develop Structured Volunteering Programs

What the results tell us: There was minimal and spotty volunteering in the face of public support and knowledge about NbS.

- Provide clear and visible opportunities to volunteer in locations close to NbS sites, from daily jobs to special events.
- Engage with universities, community organizations, and local associations to attract and retain volunteer workers.
- Offer public recognition, small incentive rewards or skill improvement coursework in an effort to encourage long-term involvement.

6.4.3. Prioritize Visibility and Accessibility of NbS Projects

What the findings demonstrate: Organizations such as Orti Generali excelled in awareness, perceived safety, and engagement - thanks to their visibility, accessibility, and regular programming.

- Enhance physical access, signage, and promotion to stimulate participation.
- Maintain visibility in collaboration with schools, social media, and social events.

6.4.4. Integrate Environmental Education into NbS Design

The findings indicate: Frequent participation in environmental education is strongly associated with behavior change and environmental awareness.

- Integrate learning aspects into NbS (e.g., guided tours, educational panels, school-based activities).
- Promote learning at the site utilizing local green infrastructure as a venue of public awareness.
- Coordinate with local learning institutions to include NbS in formal and informal curricula.

6.4.5. Use Social Feedback in Evaluating NbS Success

What the results tell us: Social indicators – such as emotional bond, sense of safety, or aesthetic pleasure – provide us with important information beyond environmental measures.

- Incorporate qualitative and survey-based social indicators within tools for assessing urban NbS.
- Use citizen feedback to adjust programming, design, and communication strategies.
- Collect longitudinal data to track how social benefits evolve over time.

6.4.6. Replicate Success Patterns from High-Impact Projects

What the outcomes indicate: Orti Generali performed as a high-impact example, with evident impacts across almost all of the indicators - as a result of sustained visibility, alignment with education, and community support.

- Review and study successful models like Orti Generali in order to find replicable design, outreach, and governance solutions.
- Apply these learnings to inform future NbS development in other neighborhoods.
- Enable adaptive learning in NbS locations to enhance the positive social impacts at the level of the entire city.

Chapter 7

7. Bibliography

1. Adamsen, L., Andersen, C., Lillelund, C., Bloomquist, K., & Møller, T. (2017). Rethinking exercise identity: A qualitative study of physically inactive cancer patients' transforming process while undergoing chemotherapy. *BMJ Open*, 7(8), e016689. <https://doi.org/10.1136/bmjopen-2017-016689>
2. Ahmad Nia, H., Atun, R. A., & Rahbarianyazd, R. (2017). Perception-based method for measuring the aesthetic quality of the urban environment. *Open House International*, 42(2), 11–19.
3. Alender, B. (2016). Understanding volunteer motivations to participate in citizen science projects: A deeper look at water quality monitoring. *Journal of Science Communication*, 15(03), A04. https://jcom.sissa.it/archive/15/03/JCOM_1503_2016_A04
4. Anguelovski, I., & Corbera, E. (2023). Integrating justice in nature-based solutions to avoid nature-enabled dispossession. *Ambio*, 52(1), 45–53.
5. Anguelovski, I., Connolly, J. J. T., Masip, L., & Pearsall, H. (2018). Assessing green gentrification in historically disenfranchised neighborhoods: A longitudinal and spatial analysis of Barcelona. *Urban Geography*, 39(3), 455–491.
6. Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4), 216–224.
7. Assumma, V., Dell'Ovo, M., Todella, E., Caprioli, C., & Rossitti, M. (2023). *Evaluating nature-based solutions impacts: A preliminary framing of assessment methods*. In O. Gervasi, B. Murgante, A. M. A. C. Rocha, C. Garau, F. Scorza, Y. Karaca, & C. M. Torre (Eds.), *Computational Science and Its Applications – ICCSA 2023 Workshops: Proceedings, Part V* (Lecture Notes in Computer Science, Vol. 14108, pp. 165–179). Springer. https://doi.org/10.1007/978-3-031-37117-2_12
8. Bauer, W. (2023). Reframing urban nature-based solutions through perspectives of environmental justice and privilege. *Urban Planning*, 8(1), 334–345. <https://doi.org/10.17645/up.v8i1.6018>
9. Baum, H. S. (2015). Citizen participation. In J. D. Wright (Ed.), *International encyclopedia of the social & behavioral sciences* (2nd ed., Vol. 3, pp. 625–630). Elsevier. <https://doi.org/10.1016/B978-0-08-097086-8.74005-0>
10. Bigdeli Rad, V., & Ngah, I. B. (2014). Assessment of quality of public urban spaces. *Science International (Lahore)*, 26(1), 335–338.
11. Boyles, A. L., Beverly, B. E. J., Fenton, S. E., Jackson, C. L., Jukic, A. M. Z., Sutherland, V. L., Baird, D. D., Collman, G. W., Dixon, D., Ferguson, K. K., & Chandler, K. J. (2021). Environmental factors involved in maternal morbidity and mortality. *Journal of Women's Health*, 30(2), 245–252. <https://doi.org/10.1089/jwh.2020.8855>
12. Bratman, G. N., Daily, G. C., Levy, B. J., & Gross, J. J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning*, 138, 41–50. <https://doi.org/10.1016/j.landurbplan.2015.02.005>
13. Bruch, C. (2023). *Imputation of missing values in survey data*. Mannheim: GESIS – Leibniz Institute for the Social Sciences. (GESIS Survey Guidelines). https://doi.org/10.15465/gesis-sg_en_044
14. Burdge, R. J., & Vanclay, F. (1996). Social impact assessment: A contribution to the state of the art series. *Impact Assessment*, 14(1), 59–86. <https://doi.org/10.1080/07349165.1996.9725886>
15. Bussell, H., & Forbes, D. (2002). Understanding the volunteer market: The what, where, who and why of volunteering. *International Journal of Nonprofit and Voluntary Sector Marketing*, 7(3), 244–257. <https://doi.org/10.1002/nvsm.183>

16. Cambridge Econometrics. (2015). *Assessing the employment and social impact of energy efficiency* (Final Report, Volume 1: Main Report). Cambridge Econometrics.
17. Caroppi, G., Pugliese, F., Gerundo, C., De Paola, F., Stanganelli, M., Urciuoli, G., Nadim, F., Oen, A., Andrés, P., & Giugni, M. (2024). A comprehensive framework tool for performance assessment of NBS for hydro-meteorological risk management. *Journal of Environmental Planning and Management*, 67(6), 1231–1257. <https://doi.org/10.1080/09640568.2023.2166818>
18. Chanchitpricha, C., & Bond, A. (2013). Conceptualising the effectiveness of impact assessment processes. *Environmental Impact Assessment Review*, 43, 65–72. <http://dx.doi.org/10.1016/j.eiar.2013.05.006>
19. Christensen, H. S. (2020). How citizens evaluate participatory processes: A conjoint analysis. *European Political Science Review*, 12(2), 239–253. <https://doi.org/10.1017/S1755773920000107>
20. Città di Torino. (2022). *Relazione tecnico-illustrativa-agronomica: Programma REACT – Interventi di adattamento per una città più vivibile* (Progetto esecutivo, Cod. Opera: 4977, CUP: C11B22000760006). Dipartimento Ambiente e Transizione Ecologica.
21. Città di Torino – Divisione Infrastrutture e Mobilità. (n.d.). Clessidra Verde – Executive project technical report [Internal Project Document].
22. City of Turin. (n.d.). *City Water Circles - CWC*. Retrieved February 10, 2025, from <https://www.torinoeuprojects.it/en/cwc-city-water-circles-2/>
23. Cloquell-Ballester, V.-A., Cloquell-Ballester, V.-A., Monterde-Díaz, R., & Santamarina-Siurana, M.-C. (2006). Indicators validation for the improvement of environmental and social impact quantitative assessment. *Environmental Impact Assessment Review*, 26, 79–105. <https://doi.org/10.1016/j.eiar.2005.06.002>
24. Comune di Torino (2020). Progetto di recupero acque piovane, tetto verde e serra aeroponica – Open 011, Torino. City Water Circles – Progetto Esecutivo, Divisione Infrastrutture e Mobilità, Ufficio Urbanizzazioni.
25. Conexus. (n.d.). *Valdocco Vivibile: NbS for liveable and climate-proof neighbourhoods, Turin*. <https://www.torinovivibile.it/aree-tematiche/valdocco-vivibile/>
26. Conti, J. (2019). *Strategies for operationalizing nature-based solutions in the private sector*. <https://www.nature.org/content/dam/tnc/nature/en/documents/NBSWhitePaper.pdf>
27. Datola, G., & Oppio, A. (2023). *Nature-based solutions design and implementation in urban systems: Dimensions, challenges and issues to construct a comprehensive evaluation framework*. In O. Gervasi et al. (Eds.), *Computational Science and Its Applications – ICCSA 2023 Workshops. Lecture Notes in Computer Science*, vol 14108 (pp. 79–90). Springer. https://doi.org/10.1007/978-3-031-37117-2_7
28. Dekker, P. (2019). From pillarized active membership to populist active citizenship: The Dutch do democracy. *Voluntas: International Journal of Voluntary and Nonprofit Organizations*, 30(1), 74–85. <https://doi.org/10.1007/s11266-018-00058-4>
29. Desmoitier, N., Kolenda, M., Holm Olsen, K., & Ryberg, M. W. (2023). Methods for assessing social impacts of policies in relation to absolute boundaries. *Environmental Impact Assessment Review*, 101, 107098. <https://doi.org/10.1016/j.eiar.2023.107098>
30. Dorst, H., van der Jagt, A., Raven, R., & Runhaar, H. (2019). Urban greening through nature-based solutions–key characteristics of an emerging concept. *Sustainable Cities and Society*, 49, 101620. <https://doi.org/10.1016/j.scs.2019.101620>
31. Dreyer, L. C., Hauschild, M. Z., & Schierbeck, J. (2006). A framework for social life cycle impact assessment. *International Journal of Life Cycle Assessment*, 11(2), 88–97. <https://doi.org/10.1065/lca2005.08.223>

32. Dumitru, A., Frantzeskaki, N., & Collier, M. (2020). Identifying principles for the design of robust impact evaluation frameworks for nature-based solutions in cities. *Environmental Science & Policy*, 112, 107–116. <https://doi.org/10.1016/j.envsci.2020.05.024>
33. Dushkova, D., & Haase, D. (2020). Not simply green: Nature-based solutions as a concept and practical approach for sustainability studies and planning agendas in cities. *Land*, 9(1), Article 19. <https://doi.org/10.3390/land9010019>
34. DUT Partnership. (n.d.). The DUT Partnership: Driving urban transitions. Retrieved, from <https://dutpartnership.eu/the-dut-partnership/>
35. Eckhard, J. (2018). Indicators of social isolation: A comparison based on survey data from Germany. *Social Indicators Research*, 139(3), 963–988. <https://doi.org/10.1007/s11205-017-1741-y>
36. Eggermont, H., Balian, E., Azevedo, J. M. N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., van Ham, C., Weisser, W. W., & Le Roux, X. (2015). Nature-based solutions: New influence for environmental management and research in Europe. *Gaia*, 24(4), 243–248. <http://dx.doi.org/10.14512/gaia.24.4.9>
37. Escorcia Hernández, J. R., Torabi Moghadam, S., & Lombardi, P. (2024). Urban sustainability in social housing environments: A spatial impact assessment in Bogotá, Colombia. *Cities*, 154, 105392. <https://doi.org/10.1016/j.cities.2024.105392>
38. Escorcia Hernández, J. R., Torabi Moghadam, S., Sharifi, A., & Lombardi, P. (2023). Cities in the times of COVID-19: Trends, impacts, and challenges for urban sustainability and resilience. *Journal of Cleaner Production*, 432, 139735. <https://doi.org/10.1016/j.jclepro.2023.139735>
39. European Commission. (2008). *The social situation in the European Union 2008: Social cohesion through equal opportunities*. Office for Official Publications of the European Communities. <https://ec.europa.eu/eurostat/en/web/products-statistical-books/-/ke-ag-09-001>
40. European Commission. (2010). *Volunteering in the European Union: Executive Summary*. https://commission.europa.eu/system/files/2020-03/exec_summary_volunteering_eu_en.pdf
41. European Commission. (2015). *Towards an EU Research and Innovation policy agenda for Nature Based Solutions & Re-Naturing Cities*. Luxembourg: Publications Office of the European Union. <https://publications.europa.eu/en/publication-detail/publication/fb117980-d5aa-46df-8edc-af367cdde202>
42. European Commission. (2021). *Evaluating the impact of nature-based solutions: A handbook for practitioners*.
43. European Commission. (2023). *Report on the quality of life in European cities*. Publications Office of the European Union. <https://doi.org/10.2776/830208>
44. European Commission. (2023). *The European Democracy Action Plan: Strengthening citizen participation in the EU*. <https://ec.europa.eu/>
45. European Commission. (n.d.). *Nature-based solutions*. <https://ec.europa.eu/research/environment/index.cfm?pg=nbs>
46. European Commission/EACEA/Eurydice. (2012). *Citizenship education in Europe*. Education, Audiovisual and Culture Executive Agency. <https://doi.org/10.2797/83012>
47. European Environment Agency. (2024, December 10). *Premature deaths due to exposure to fine particulate matter in Europe*. <https://www.eea.europa.eu/en/analysis/indicators/health-impacts-of-exposure-to>
48. European Union. (2014). *Morbidity statistics in the EU: Report on pilot studies (Statistical Working Papers)*. Publications Office of the European Union. <https://ec.europa.eu/eurostat/documents/3888793/5858521/KS-TC-14-003-EN-N.pdf/bd959e6e-10ed-4078-915e-308941c02811>

49. Eurostat. (2023). *Civic engagement and participation in the EU*. <https://ec.europa.eu/eurostat/>
50. Eurostat. (2023). *Demography of Europe 2023 edition* [Interactive publication]. Publications Office of the European Union. <https://ec.europa.eu/eurostat/web/interactive-publications/demography-2023>
51. Eurostat. (2024). *Gender gap in life expectancy at birth, 2022* [Image]. Eurostat. <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Gender-gap-life-expectancy-at-birth-2022V1.jpg>
52. Ewert, A., & Sibthorp, J. (2009). Creating outcomes through environmental volunteerism. *Environmental Education Research*, 15(3), 229–250. <https://doi.org/10.1080/13504620902807505>
53. Ferkany, M., & Whyte, K. P. (2011). The importance of participatory virtues in the future of environmental education. *Journal of Agricultural and Environmental Ethics*, 25(3), 419–434. <https://doi.org/10.1007/s10806-011-9312-8>
54. Ferreira, V., Barreira, A. P., Loures, L., Antunes, D., & Panagopoulos, T. (2020). Stakeholders' engagement on nature-based solutions: A systematic literature review. *Sustainability*, 12(2), 640. <https://doi.org/10.3390/su12020640>
55. Frantzeskaki, N. (2019). Seven lessons for planning nature-based solutions in cities. *Environmental Science & Policy*, 93, 101–111. <https://doi.org/10.1016/j.envsci.2018.12.033>
56. Frantzeskaki, N., McPhearson, T., Collier, M., & Pelling, M. (2019). *Nature-based solutions for urban climate change adaptation: Linking science, policy, and practice communities for evidence-based decision-making*. *BioScience*, 69(2), 174–185. <https://doi.org/10.1093/biosci/biz137>
57. Freitas, Â., Rodrigues, T. C., & Santana, P. (2020). Assessing urban health inequities through a multidimensional and participatory framework: Evidence from the EURO-HEALTHY project. *Journal of Urban Health*, 97(6), 857–875. <https://doi.org/10.1007/s11524-020-00471-5>
58. Fung, A. (2006). Varieties of participation in complex governance. *Public Administration Review*, 66(s1), 66–75. <https://doi.org/10.1111/j.1540-6210.2006.00667.x>
59. Gallego Carrera, D., & Mack, A. (2010). Sustainability assessment of energy technologies via social indicators: Results of a survey among European energy experts. *Energy Policy*, 38(2), 1030–1039. <https://doi.org/10.1016/j.enpol.2009.10.055>
60. GHK. (2010). *Volunteering in the European Union: Final Report*. European Commission.
61. Giachino, C., Pattanaro, G., Bertoldi, B., Bollani, L., & Bonadonna, A. (2021). Nature-based solutions and their potential to attract the young generations. *Land Use Policy*, 101, 105176. <https://doi.org/10.1016/j.landusepol.2020.105176>
62. Golet, G. H., Roberts, M. D., Luster, R. A., Werner, G., Larsen, E. W., Unger, R., & White, G. G. (2006). Assessing societal impacts when planning restoration of large alluvial rivers: A case study of the Sacramento River Project, California. *Environmental Management*, 37(6), 862–879. <https://doi.org/10.1007/s00267-004-0167-x>
63. GREEN-INC. (n.d.). *GREEN-INC: GRowing Effective & Equitable Nature-based Solutions through INclusive Climate Actions*. Retrieved February 15, 2025, from <https://green-inc.eu/>
64. Greenwood, J. (2018). The European Citizens' Initiative: Bringing the EU closer to its citizens? *Comparative European Politics*. <https://doi.org/10.1057/s41295-018-0130-2>
65. Grieco, C., Michelini, L., & Iasevoli, G. (2015). Measuring value creation in social enterprises: A cluster analysis of social impact assessment models. *Nonprofit and Voluntary Sector Quarterly*, 44(6), 1173–1193. <https://doi.org/10.1177/0899764014555986>
66. Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). *Nature and health*. *Annual Review of Public Health*, 35, 207–228. <https://doi.org/10.1146/annurev-publhealth-032013-182443>

67. Hauschild, M. Z., Dreyer, L. C., & Jørgensen, A. (2008). Assessing social impacts in a life cycle perspective—Lessons learned. *CIRP Annals - Manufacturing Technology*, 57, 21–24. <https://doi.org/10.1016/j.cirp.2008.03.002>
68. Hill, S. (2016). Assessing (for) impact: Future assessment of the societal impact of research. *Palgrave Communications*, 2, 16073. <https://doi.org/10.1057/palcomms.2016.73>
69. Hollweg, K. S., Taylor, J. R., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). *Developing a framework for assessing environmental literacy*. North American Association for Environmental Education. <https://cdn.naaee.org/sites/default/files/inline-files/devframewkassessenvlitonlineed.pdf>
70. Interorganizational Committee on Guidelines and Principles for Social Impact Assessment. (1994). *Guidelines and principles for social impact assessment*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
71. ISTAT. (2024). Italian Institute of Statistics: *Urban civic participation report*. <https://www.istat.it/>
72. Istat. (2019). Social relationships. In *Bes 2019: Equitable and sustainable well-being in Italy* (pp. 71–85). Italian National Institute of Statistics (Istat). <https://www.istat.it/en/archive/well-being>
73. Istituto Nazionale di Statistica (ISTAT). (2023). *SDGs report 2023: Statistical information for the 2030 Agenda in Italy*. <https://www.istat.it/en/archive/sdg-report-2023>
74. Istrate, A.-L., & Hamel, P. (2023). Urban nature games for integrating nature-based solutions in urban planning: A review. *Landscape and Urban Planning*, 239, 104860. <https://doi.org/10.1016/j.landurbplan.2023.104860>
75. Italia. (2021). Legge 1 aprile 2021, n. 46: *Delega al Governo per riordinare, semplificare e potenziare le misure a sostegno dei figli a carico attraverso l'assegno unico e universale*. Gazzetta Ufficiale della Repubblica Italiana. <https://www.gazzettaufficiale.it/eli/id/2021/04/06/21G00057/sg>
76. IUCN. (2016). *Resolution 69 on Defining Nature-based Solutions (WCC-2016-Res-069)*. IUCN Resolutions, Recommendations and Other Decisions. World Conservation Congress Honolulu, Hawai'i, USA.
77. Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J., Zaunberger, K., & Bonn, A. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society*, 21(2), 39. <https://doi.org/10.5751/ES-08373-210239>
78. Ke, X., Li, W., Rui, L., Qiu, X., & Guo, S. (2010). WCDMA KPI framework definition methods and applications. *2010 2nd International Conference on Computer Engineering and Technology* (Vol. 4, pp. 471–477). IEEE. <https://doi.org/10.1109/ICCET.2010.5486170>
79. Kerber, L. K. (1997). The meanings of citizenship. *The Journal of American History*, 84(3), 833–854. <https://www.jstor.org/stable/2953082>
80. Kettunen, M., Charveriat, C., Farmer, A., Gionfra, S., Schweitzer, J. P., & Stainforth, T. (2018). *Sustainable Development Goals (SDGs) at the UN High Level Political Forum (HLPF), New York, 16–18 July 2018* (Policy Department for Economic, Scientific and Quality of Life Policies; PE 619.026). European Parliament. <https://doi.org/10.2861/629985>
81. Kothencz, G., Kolcsár, R., Cabrera-Barona, P., & Szilassi, P. (2017). Urban green space perception and its contribution to well-being. *International Journal of Environmental Research and Public Health*, 14(7), 766. <https://doi.org/10.3390/ijerph14070766>
82. Lakshmisha, A., Nazar, A. F., & Nagendra, H. (2024). Nature-based solutions in cities of the global South—The ‘where, who and how’ of implementation. *Environmental Research: Ecology*, 3(025005). <https://doi.org/10.1088/2752-664X/ad53cf>

83. Lami, I. M., & Mecca, B. (2021). Assessing social sustainability for achieving sustainable architecture. *Sustainability*, 13, 142. <https://doi.org/10.3390/su13010142>
84. Legge 20 agosto 2019, n. 92. (2019). Introduzione dell'insegnamento scolastico dell'educazione civica. *Gazzetta Ufficiale della Repubblica Italiana, Serie Generale*, n. 195 del 21-08-2019. https://www.gazzettaufficiale.it/atto/stampa/serie_generale/originario
85. Li, X., Hijazi, I., Koenig, R., Lv, Z., Zhong, C., & Schmitt, G. (2016). Assessing essential qualities of urban space with emotional and visual data based on GIS technique. *ISPRS International Journal of Geo-Information*, 5(11), 218. <https://www.mdpi.com/2220-9964/5/11/218>
86. Maes, J., & Jacobs, S. (2015). Nature-based solutions for Europe's sustainable development. *Conservation Letters*, 10, 121–124. <https://doi.org/10.1111/conl.12216>
87. Mahmoud, I. H., Morello, E., Vona, C., Benciolini, M., Sejdullahu, I., Trentin, M., & Pascual, K. H. (2021). *Setting the social monitoring framework for Nature-Based Solutions impact: Methodological approach and pre-greening measurements in the case study from CLEVER Cities Milan*. *Sustainability*, 13(17), 9672. <https://doi.org/10.3390/su13179672>
88. McCloughan, P., Batt, W. H., Costine, M., & Scully, D. (2011). *Participation in volunteering and unpaid work (2nd European Quality of Life Survey)*. European Foundation for the Improvement of Living and Working Conditions. <https://doi.org/10.2806/1399>
89. Measham, T. G., & Barnett, G. B. (2008). Environmental volunteering: Motivations, modes and outcomes. *Australian Geographer*, 39(4), 537–552. <https://doi.org/10.1080/00049180802419237>
90. Mela, A., Tousi, E., & Varelidis, G. (2025). Assessing urban public space quality: A short questionnaire approach. *Urban Science*, 9(3), Article 56. <https://doi.org/10.3390/urbansci9030056>
91. Menardo, E., Cubelli, R., & Balboni, G. (2022). Adaptation of the personal social capital brief scale for the measurement of the offline and online social capital in Italy. *PLOS ONE*, 17(9), e0272454. <https://doi.org/10.1371/journal.pone.0272454>
92. Monroe, M. C., Andrews, E., & Biedenweg, K. (2007). A framework for environmental education strategies. *Applied Environmental Education & Communication*, 6(3), 205–216. <https://doi.org/10.1080/15330150801944416>
93. Muringani, J., Fitjar, R. D., & Rodríguez-Pose, A. (2021). Social capital and economic growth in the regions of Europe. *EPA: Economy and Space*, 53(6), 1412–1434. <https://doi.org/10.1177/0308518X211000059>
94. Muringani, J., Rodríguez-Pose, A., & Fitjar, R. (2025, April 20). Bridging, not bonding, for regional growth. *VoxEU*. <https://cepr.org/voxeu/columns/bridging-not-bonding-regional-growth>
95. Napoli, P. (2014). *Measuring media impact: An overview of the field*. Media Impact Project, USC Annenberg Norman Lear Center. <http://www.learcenter.org/pdf/measuringmedia.pdf>
96. Nature editorial (2017). 'Nature-based solutions' is the latest green jargon that means more than you might think [editorial]. *Nature*, 541, 133–134. <https://doi.org/10.1038/541133b>
97. Nizzolino, S.; Canals, A.; Temperini, M. (2023). Validation of the Italian Version of the Community of Inquiry Survey. *Education Sciences*, 13(12), 1200. <https://doi.org/10.3390/educsci13121200>
98. Nursey-Bray, M., Masud-All-Kamal, M., Di Giacomo, M., & Millcock, S. (2022). *Building community resilience through youth volunteering: Towards a new model*. *Regional Studies, Regional Science*, 9(1), 242–263. <https://doi.org/10.1080/21681376.2022.2067004>
99. O'Brien, L., Townsend, M., & Ebdon, M. (2010). 'Doing Something Positive': Volunteers' Experiences of the Well-Being Benefits Derived from Practical Conservation Activities in Nature. *Voluntas: International Journal of Voluntary and Nonprofit Organizations*, 21(4), 525–545. <https://doi.org/10.1007/s11266-010-9149-1>
100. OECD. (2022). *OECD Better Life Index*. <http://www.oecdbetterlifeindex.org/>

101. Olmos, L., Rodilla, P., Fernandes, C., Frias, P., Ahcin, P., Morch, A., ... & Fontaine, A. (2016). *Definition of Key Performance Indicators for the assessment of design options* (Market4RES, Deliverable D3.3). <https://market4res.eu/results/reports/>
102. O'Neill, M. S., Carter, R., Kish, J. K., Gronlund, C. J., White-Newsome, J. L., Manarolla, X., Zanobetti, A., & Schwartz, J. D. (2009). Preventing heat-related morbidity and mortality: New approaches in a changing climate. *Maturitas*, 64(2), 98–103. <https://doi.org/10.1016/j.maturitas.2009.08.005>
103. Orti Generali. (n.d.). The project. Retrieved March 28, 2025, from <https://www.ortigenerali.it/en/the-project/>
104. Ozanne, J. L., Davis, B., Murray, J. B., Grier, S., Benmecheddal, A., Downey, H., Ekpo, A. E., Garnier, M., Hietanen, J., Le Gall-Ely, M., Seregina, A., Thomas, K. D., & Veer, E. (2017). Assessing the societal impact of research: The relational engagement approach. *Journal of Public Policy & Marketing*, 36(1), 1–14. <https://doi.org/10.1509/jppm.14.1211>
105. Pellerey, V., & Torabi Moghadam, S. (2025). A place-based framework for assessing the effectiveness of inclusive climate actions for nature-based solutions in cities. *Journal of Cleaner Production*, 486, 144566. <https://doi.org/10.1016/j.jclepro.2024.144566>
106. Pérez-Álvarez, J. M., Maté, A., Gómez-López, M. T., & Trujillo, J. (2018). Tactical business-process-decision support based on KPIs monitoring and validation. *Computers in Industry*, 102, 23–39. <https://doi.org/10.1016/j.compind.2018.08.001>
107. Peters, K., Elands, B., & Buijs, A. (2010). Social interactions in urban parks: Stimulating social cohesion? *Urban Forestry & Urban Greening*, 9(2), 93–100. <https://doi.org/10.1016/j.ufug.2009.11.003>
108. ProGÍreg. (n.d.-a). Green indoor and outdoor walls – Living Lab Turin-Mirafiori Sud. Retrieved March 28, 2025, from <https://www.progireg.eu/>
109. ProGÍreg. (n.d.-b). Green roof at WOW – Living Lab Turin-Mirafiori Sud. Retrieved March 28, 2025, from <https://www.progireg.eu/>
110. Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. Simon & Schuster. <https://books.google.it/books?hl=en&lr=&id=rd2ibodep7UC>
111. Qiu, L., & Nielsen, A. B. (2015). Are perceived sensory dimensions a reliable tool for urban green space assessment and planning? *Landscape Research*, 40(7), 834–854. <https://doi.org/10.1080/01426397.2015.1029445>
112. Richards, D. R., Belcher, R. N., Carrasco, L. R., Edwards, P. J., Fatichi, S., Hamel, P., Masoudi, M., McDonnell, M. J., Peleg, N., & Stanley, M. C. (2022). Global variation in contributions to human well-being from urban vegetation ecosystem services. *One Earth*, 5, 522–533. <https://doi.org/10.1016/j.oneear.2022.04.006>
113. Rosenzweig, W., Clark, C., Long, D., & Olsen, S. (2004). *Double bottom line project report: Assessing social impact in double bottom line ventures* [Working Paper Series]. University of California, Berkeley. <https://escholarship.org/uc/item/80n4f1mf>
114. Royo, S., Yetano, A., & Acerete, B. (2011). Citizen participation in German and Spanish local governments: A comparative study. *International Journal of Public Administration*, 34(3), 139–150. <https://doi.org/10.1080/01900692.2010.533070>
115. Ruel, E. E., Wagner, W. E., III, & Gillespie, B. J. (2016). *The practice of survey research: Theory and applications*. SAGE Publications.
116. Sairinen, R., & Kumpulainen, S. (2006). Assessing social impacts in urban waterfront regeneration. *Environmental Impact Assessment Review*, 26, 120–135. <https://doi.org/10.1016/j.eiar.2005.05.003>

117. Sarason, I. G. (Ed.). (1985). *Social support: Theory, research, and applications*. Springer Science & Business Media.
118. Schaubroeck, T. (2018). Towards a general sustainability assessment of human/industrial and nature-based solutions. *Sustainability Science*, 13, 1185–1191. <https://doi.org/10.1007/s11625-018-0559-0>
119. Schelter, S., Biessmann, F., & Salinas, D. (2021). A benchmark for data imputation methods. *Frontiers in Big Data*, 4, 693674. <https://doi.org/10.3389/fdata.2021.693674>
120. Schenk, L. (2021). *Social networks of at-risk youth: Social support from bonding and bridging relationships* [Doctoral dissertation, Erasmus Universiteit Rotterdam].
121. Secretariat of the Convention on Biological Diversity. (2009). *Connecting biodiversity and climate change mitigation and adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change* (CBD Technical Series No. 41, 126 pp.). Secretariat of the Convention on Biological Diversity. <https://www.cbd.int/doc/publications/cbd-ts-41-en.pdf>
122. Sloodweg, R., Vanclay, F., & van Schooten, M. (2001). Function evaluation as a framework for the integration of social and environmental impact assessment. *Impact Assessment and Project Appraisal*, 19(1), 19–28. <https://doi.org/10.3152/147154601781767186>
123. Smock, C. R., Schultz, C. L., Gustat, J., Layton, R., & Slater, S. J. (2024). Perceptions of knowledge and experience in nature-based health interventions. *International Journal of Environmental Research and Public Health*, 21(9), 1182. <https://doi.org/10.3390/ijerph21091182>
124. Snep, R. P. H., Klostermann, J., Lehner, M., & Weppelman, I. (2023). Social housing as focus area for Nature-based Solutions to strengthen urban resilience and justice: Lessons from practice in the Netherlands. *Environmental Science & Policy*, 145, 164–174. <https://doi.org/10.1016/j.envsci.2023.02.022>
125. Snyder, M., & Omoto, A. M. (2008). *Volunteerism: Social issues perspectives and social policy implications*. *Social Issues and Policy Review*, 2(1), 1–36. <https://doi.org/10.1111/j.1751-2409.2008.00009.x>
126. Solans-Domènech, M., Pons, J. M. V., Adam, P., Grau, J., & Aymerich, M. (2019). Development and validation of a questionnaire to measure research impact. *Research Evaluation*, 28(3), 253–262. <https://doi.org/10.1093/reseval/rvz007>.
127. Sowińska-Świerkosz, B., & García, J. (2022). What are nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nature-Based Solutions*, 2, 100009. <https://doi.org/10.1016/j.nbsj.2022.100009>
128. Subiza-Pérez, M., Hauru, K., Korpela, K., Haapala, A., & Lehvävirta, S. (2019). Perceived Environmental Aesthetic Qualities Scale (PEAQS) – A self-report tool for the evaluation of green-blue spaces. *Urban Forestry & Urban Greening*, 43, Article 126383. <https://doi.org/10.1016/j.ufug.2019.126383>
129. Sujitha, J., & Lavanya, S. R. (2018). A literature survey on missing value imputation methods in data mining. In *Proceedings of the International Conference on Computing Intelligence and Data Science (ICCIDS 2018)* (pp. 15–19). IOSR Journal of Engineering. <https://www.iosrjen.org/Papers/Conf.ICCIDS-2018/Volume-6/4.%2015-19.pdf>
130. Swiatek, C. (2019). European academic libraries key performance indicators (KPI): How comparison helps decision making. *Performance Measurement and Metrics*, 20(3), 143–158. <https://doi.org/10.1108/PMM-08-2019-0041>
131. Tang, B.-S., Wong, S.-W., & Lau, M. C.-H. (2008). Social impact assessment and public participation in China: A case study of land requisition in Guangzhou. *Environmental Impact Assessment Review*, 28, 57–72. <https://doi.org/10.1016/j.eiar.2007.03.004>
132. Taylor, C. N., Bryan, C. H., & Goodrich, C. G. (1990). *Social assessment: Theory, process & techniques* (Studies in Resource Management No. 7). Centre for Resource Management.

133. Tedesco, A. M., Brancalion, P. H. S., Hak Hepburn, M. L., Walji, K., Wilson, K. A., Possingham, H. P., Dean, A. J., Nugent, N., Elias-Trostmann, K., Perez-Hammerle, K.-V., & Rhodes, J. R. (2022). The role of incentive mechanisms in promoting forest restoration. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 378, 20210088. <https://doi.org/10.1098/rstb.2021.0088>
134. Thomson, G., & Hoffman, J. (n.d.). *Measuring the success of environmental education programs*. Canadian Parks and Wilderness Society & Sierra Club of Canada, BC Chapter. https://macaw.pbworks.com/f/measuring_ee_outcomes.pdf
135. Torino Vivibile. (n.d.). *Valdocco Vivibile*. Retrieved October 16, 2024, from <https://www.torinovivibile.it/aree-tematiche/valdocco-vivibile/>
136. United Nations. (2020). SDG 16.7: *Ensure responsive, inclusive, participatory, and representative decision-making*. <https://sdgs.un.org/goals/goal16>
137. URS. (2013). *Nimba Western Area Iron Ore Concentrator Mining Project: Environmental and social impact assessment – Volume 5, Part 3: Cultural heritage assessment* [Report]. Prepared for ArcelorMittal Liberia Limited.
138. Uysal, Ç., Yılmaz, Ö., Koç, E., Yöntem, E., & Koppelaar, R. (2021). An environmental evaluation framework for planning and monitoring of nature based solutions for sustainable urban management. *Open Research Europe*, 1, 97. <https://doi.org/10.12688/openreseurope.13655.2>
139. Vanclay, F. (2000). Social impact assessment [Contributing paper]. In *Thematic Review V.2: Environmental and social assessment for large dams*. World Commission on Dams. Retrieved from <http://www.dams.org>
140. Vanclay, F. (2002). Conceptualising social impacts. *Environmental Impact Assessment Review*, 22, 183–211. [https://doi.org/10.1016/S0195-9255\(01\)00105-6](https://doi.org/10.1016/S0195-9255(01)00105-6)
141. Vanclay, F. (2006). Principles for social impact assessment: A critical comparison between the international and US documents. *Environmental Impact Assessment Review*, 26, 3–14. <https://doi.org/10.1016/j.eiar.2005.05.002>
142. Vanclay, F., Esteves, A. M., Aucamp, I., & Franks, D. (2015). *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects*. International Association for Impact Assessment.
143. Vanclay, F., & Esteves, A. M. (Eds.). (2007). *New directions in social impact assessment: Conceptual and methodological advances*. Edward Elgar Publishing.
144. Vanclay, F. (2020). Reflections on social impact assessment in the 21st century. *Impact Assessment and Project Appraisal*, 38(2), 126–131. <https://doi.org/10.1080/14615517.2019.1685807>
145. Van den Bosch, M., & Sang, A. O. (2017). Urban natural environments as nature-based solutions for improved public health: A systematic review of reviews. *Environmental Research*, 158, 373–384. <https://doi.org/10.1016/j.envres.2017.05.040>
146. Van Staveren, I., & Knorringa, P. (2007). Unpacking social capital in economic development: How social relations matter. *Review of Social Economy*, 65(1), 107–135. <https://doi.org/10.1080/00346760601132147>
147. Verbeiren, B., & Verstraeten, E. (2024). *Driving Urban Transitions: GRowing Effective & Equitable Nature-based Solutions through INclusive Climate Actions (GREEN-INC)*. Vrije Universiteit Brussel. <https://researchportal.vub.be/en/projects/driving-urban-transitions-growing-effective-equitable-nature-base>
148. Vukovic, T., Salama, A. M., Mitrovic, B., & Devetakovic, M. (2021). Assessing public open spaces in Belgrade – A quality of urban life perspective. *Archnet-IJAR: International Journal of Architectural Research*, 15(3), 505–523. <https://doi.org/10.1108/ARCH-04-2020-0064>

149. Wamsler, C., Wickenberg, B., Hanson, H., Alkan Olsson, J., Stålhammar, S., Björn, H., Falck, H., Gerell, D., Oskarsson, T., Simonsson, E., Torffvit, F., & Zelmerlöv, F. (2020). Environmental and climate policy integration: Targeted strategies for overcoming barriers to nature-based solutions and climate change adaptation. *Journal of Cleaner Production*, 247, 119154. <https://doi.org/10.1016/j.jclepro.2019.119154>
150. Wang, L., Liu, X., Zheng, H., & Caneparo, L. (2024). Quality improvement of urban public space from the perspective of the flâneur. *Land*, 13(6), 808. <https://doi.org/10.3390/land13060808>
151. Wang'ombe, G. (2024). The impact of urban green spaces on community health and well-being. *International Journal of Arts, Recreation and Sports*, 3(3), 14–25. <https://doi.org/10.47941/ijars.1941>
152. Weidema, B. P. (2006). The integration of economic and social aspects in life cycle impact assessment. *International Journal of Life Cycle Assessment*, 11(1), 89–96. <https://doi.org/10.1065/lca2006.04.016>
153. Zhu, D., Fraser, L., Kendal, D., Zhang, Y., & Flies, E. J. (2023). Nature-based solutions in Australia: A systematic quantitative literature review of terms, application and policy relevance [Preprint]. *bioRxiv*. <https://doi.org/10.1101/2023.05.11.538642>