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Setting the Social Monitoring Framework for Nature-Based Solutions Impact: Methodological Approach and Pre-Greening Measurements in the Case Study from CLEVER Cities Milan

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Abstract: Nature-based solutions (NBS) are currently being deployed in many European Commission Horizon 2020 projects in reaction to the increasing number of environmental threats, such as climate change, unsustainable urbanization, degradation and loss of natural capital and ecosystem services. In this research, we consider the application of NBS as a catalyst for social inclusivity in urban regeneration strategies, enabled through civic participation in the co-creation of green interventions with respect to social cohesion and wellbeing. This article is focused on a social monitoring framework elaborated within the H2020 CLEVER Cities project, with the city of Milan as a case study. Firstly, we overviewed the major regeneration challenges and expected co-benefits of the project, which are mainly human health and wellbeing, social cohesion and environmental justice, as well as citizen perception about safety and security related to the NBS implementation process. Secondly, we examined the relevance of using NBS in addressing social co-benefits by analyzing data from questionnaires against a set of five major indicators, submitted to citizens and participants of activities during pre-greening interventions: (1) Place, use of space and relationship with nature, (2) Perceived ownership and sense of belonging, (3) Psychosocial issues, social interactions and social cohesion, (4) Citizen perception about safety and security, and lastly, we analyzed (5) knowledge about CLEVER interventions and NBS benefits in relation to socio-demographics of the questionnaires' respondents. Thirdly, we cross-referenced a wind-rose multi-model of co-benefits analysis for NBS across the regeneration challenges of the project. Because of the COVID-19 emergency, in this research we mainly focused on site observations and online questionnaires, as well as on monitoring pre-greening scenarios in three Urban Living Labs (ULLs) in Milan, namely CLEVER Action Labs. Lastly, this study emphasizes the expected social added values of NBS impact over long-term urban regeneration projects. Insights from the pre-greening surveys results accentuate the importance of the NBS interventions in citizens' perceptions about their wellbeing, general health and strong sense of neighborhood belonging. A wider interest towards civic participation in co-management and getting informed about NBS interventions in the Milanese context is also noted.

Keywords: nature-based solutions; social monitoring; social cohesion; co-creation; urban living lab; CLEVER Cities

1. Introduction

While many scientific contributions discuss the definitions and the theoretical frameworks of monitoring environmental impacts related to nature-based solutions (NBS) [1–3]

hands-on experiences and evidence-based effects from cities are still required to improve our understanding of the range of social, wellbeing and general health benefits provided by NBS. This is a key first step for promoting their introduction in urban planning policies and decision-making processes in cities [4,5]. Not only the development of conceptual models of social impacts, but evidence-based monitoring frameworks related to NBS in urban environments are also a relatively new topic in academic research and fairly peripheral [6,7]. In theory, the original definition of NBS derives from the International Union for Conservation of Nature (IUCN) 2013–2016 Programme as: *"actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges (e.g., climate change, food and water security or natural disasters) effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits"* [8–10]. The European Commission [11] gives a broader definition of NBS, as *"actions inspired by, supported by or copied from nature that aim to help societies address a variety of environmental, social and economic challenges in sustainable ways"*. According to the European Commission scopes, NBS can transform environmental and societal challenges into innovation opportunities, by turning natural capital into a source for green growth and sustainable development for application in urban areas [12–15].

In practice, implementing NBS concepts exceeds the boundaries of traditional urban regeneration approaches that aim to "protect and preserve nature" by also considering the enhancement and restoration of urban ecosystem services [16,17] in addition to the enhancement of social impacts generated from NBS [14]. Specifically, relative to the topics of social justice and social cohesion, NBS have been linked to the notion of environmental justice across studies that explore the role that providing equal access to neighborhood green spaces has in the fostering of social cohesion. Such spaces bridge and bond social capital and support the cultural integration of typically marginalized and fragile social groups (vulnerable groups) such as the elderly, immigrants, persons with disabilities, chronic diseases, etc. (i.e., recognition-based justice) [7,18–21].

It is critical to note that NBS are believed to enhance levels of social inclusivity in urban planning "only if" they are supported by citizen engagement and public participation practices throughout the implementation [22–24]. Haase et al. [25] stress the potential for NBS to generate positive impacts on social inclusion whenever implemented. This aspect will depend on: (1) respect for local urban and institutional contexts, (2) the type of NBS to be implemented; as well as (3) the different actors and stakeholders who are to be involved in the project execution. In a similar manner, Dumitru et al. [1] emphasizes the optimal performance of NBS depending on their social uptake and continued use overtime.

Moreover, scientific research pinpoints the potential of NBS to deliver social-ecological justice in urban planning [26]. In the latest publication by Beute et al. [27] they emphasize the positive impact NBS have on human health and wellbeing, which also further strengthens social equity through the accessibility to green and blue infrastructures. The COVID-19 pandemic painfully pointed out the lack of regular use of green spaces while emphasizing the increased interest in connectedness with nature and the critical role proximity to green spaces plays in improving mental and physical health and wellbeing [28,29].

In addition, NBS are not simply 'just' green; rather, they are considered to be essential urban design measures for green and blue infrastructure, capable of providing multiple environmental purposes. For instance, scientific evidence highlights the role of policies at local and metropolitan scales to promote the use of NBS as multiple-benefit solutions for climate-change-related effects on health, wellbeing and citizens' sense of ownership. Broader general evidence discusses that just the environmental-related impact of NBS could be related to a deeper, more widespread knowledge of their co-benefits, connectedness to nature in relation with sociodemographic aspects as well as increasing community engagement and place-based ownership [28,30–32].

Connection and relationship with nature is associated with an improvement in people's general health and wellbeing. This is supported by scientific evidence and well-established theories, such as Attention Restoration Theory [33,34] and the Stress Recovery

Theory [33]. However, in recent years, studies are emerging that support the need to bring the psychological restorative capacity of nature to urban environments [35–37]. This is where urban interventions integrating NBS, such as those being carried out in the CLEVER Cities project in Milan as explained later in this article, play an important role in providing evidence of the benefits of natural elements over health and well-being. In addition, NBS in the urban environment are associated with another co-benefit, which is the increase and improvement of social relations because of the positive impact they have on social cohesion and the feeling of belonging to a place. Hence, the integration of NBS in urban public spaces, with their associated co-benefits, allows for the recovery of the cultural functions of these spaces and their consideration as socio-ecosystems. The CLEVER Cities project focuses on implementing NBS using a pathway of co-creation that is community-driven through the monitoring of the physical and social effects of NBS experimentations. Special attention is given to Milan city context and the selection of relevant regeneration challenges to specifically address, according to the areas of intervention.

In this article, we aim to shed some light on the gap in knowledge between the theoretical models of NBS, social monitoring and experiences from real world case studies such as the CLEVER Cities application in Milan The theoretical models of NBS promote them as problem solvers to climate and social challenges; however, the real experience of using NBS through Horizon 2020 projects and beyond is still lagging behind on evidence to showcase whether they really solve all the problems they are touted to solve, especially regarding intersections with gender equity, accessibility to green areas with respect to social cohesion aspects, etc. (Nonetheless, a quick Scopus and Science Direct databases' review of the literature reveals a major lack in monitoring methodologies specifically related to NBS pre- and post-greening implementation and their impacts on wellbeing in general terms, as well as psychosocial aspects connected to social cohesion specifically. The query included "Social Monitoring" OR "Social perception" AND "nature-based solutions" in two datasets by keywords AND title, always revealed less than 100 publications after a schematic check of relevance on the impact from a human-centred approach. See https://www.sciencedirect.com/search?qs=social%20monitoring%3B%20nature-based%20solutions&years=2022%2C2021&lastSelectedFacet=publicationTitles&publicationTitles=271784 (accessed on 20 April 2021)).

In the CLEVER Cities project (For more information on CLEVER Cities project, see https://clevercities.eu/the-project/), which started in 2018, the physical medium for the implementation of NBS is the ULL (Urban Living Labs, hereafter CLEVER Action Labs, CALs), and all the pilot projects' results in this article are referring to the social co-monitoring activities happening during the pre-greening phase of the project. Moreover, data are analyzed according to a co-designed methodological pathway initially developed by the responsible partner POLIMI, supported by ELIANTE and then shared with all the local partners in Milan (The stakeholders involved in this collaborative process were mainly a university partner (DAStU—Politecnico di Milano, hereafter POLIMI), a facilitating partner (Eliante), the Municipality of Milan (CDM), Ambiente Italia Srl. (AMBIT), the Mobility and Environmental Agency of Milan (AMAT), Rete Ferroviaria Italiana (RFI) and Italferr (Società Italferr Spa—Gruppo Ferrovie dello Stato italiane).) For more on the co-creation of CLEVER Cities see [38,39].

2. Materials and Research Context

The reflections in this research article connect the social influences generated from the co-design activities for integrating NBS in urban regeneration processes carried out with a wide array of public stakeholders in the city of Milan. In CLEVER Cities, the co-design activities are considered the first phase of a complete co-creation pathway that encompasses other phases of co-implementation, co-monitoring and co-development of NBS [39,40]. In particular, the co-creation phases and tools were conceived with some flexibility, in order to take into account the different opportunities that diverse NBS types and actors involved (e.g., in terms of scale, ownership, localization) offer regarding shared decision-making.

This was done by monitoring and analyzing a set of established indicators related to the social impacts of NBS during the pre-greening phase of the project. Specifically, the methodology presented in this article is related to three main urban regeneration challenges identified by the CLEVER Cities project consortium and locally by the Milanese team: (1) human health and wellbeing, (2) social cohesion and environmental justice and (3) citizen safety and security perception.

The social monitoring impact framework falls within the project activities and Work Package 4, "Assessing NBS impact through the CLEVER Monitor", related to the monitoring and impact measurement of NBS implementation generally [41]. Focus on these specific problems has been highlighted by the municipality for Milan, in order to ensure resilience related to heat waves and water management issues generated within dense urbanized areas. This challenge can cause health and safety risks to vulnerable targets such as the chronically diseased, young children, and elders.

Throughout the two and half years of the project, a set of Key Performance Indicators (KPIs) were identified and divided into two main sets by category of measurement (environmental and social KPIs). Within the project's wider monitoring plans, the methodological framework presented in this article is only related to the social KPIs utilized and is based on the need to evaluate and monitor the advancements of the social impacts related to NBS co-implementation in the city of Milan. The Local Monitoring Team (LMT) started by identifying the main environmental and social aspects to be evaluated. Next, the team analyzed them with respect to the specific CALs in Milan and, finally, verified them in different team meetings starting in February 2019 and onwards.

In March 2019, three collaborative workshops were conducted, one per CAL. A Theory of Change (ToC) collaborative activity was carried out in order to forecast the possible expected outcomes in each CAL context. A first version of the Local Monitoring Plan (LMP) was developed afterwards in June 2019. The social monitoring methodology was developed collaboratively with all the interested stakeholder groups that were part of the Milan LMT. The initial idea was to develop a mixed methodological framework using a variety of quantitative and qualitative measurement tools such as: surveys, on site observations, interviews with stakeholders, focus groups and online questionnaires. The scientific validation (in this sense: scientific validation refers to verifying actual needs from site visits and focus groups to concretize the methodological framework) of the LMP and social monitoring methodological framework initially started in September 2019 during the Milan Green Week festival by conducting site visits to the three CALs, including a guided tour to Milan's existing green roofs and walls for CAL 1, a tour of Giambellino Park 129 for CAL 2, and the Tibaldi train stop for CAL 3. The Project coordinator and other Front Runner Cities' leaders were also invited to site visits and observations within events occurring at the festival, (For more information on CLEVER Cities Milan, see https://milanoclever.net/).

From October 2019 until February 2020, a first tailored methodology was drafted and shared with CAL leaders to check on the scope and the set of indicators, including the feasibility of measuring a pre-greening baseline built on place-based criterion. Later on, the arrival of the COVID-19 pandemic constrained the number of tools available to the team, leading to the choice of submitting online questionnaires starting in February and March 2020 when emergency levels of sickness hit Milan and blocked all activities in a hard lockdown [42–44]. The complete LMP for the pre-greening phase of each CAL, including the social KPIs, was then co-designed and approved by all the involved partners based on their specific interests.

For each CAL, a lead partner is currently guiding the co-implementation of the NBS and is therefore responsible for following up the data-collection process and refining the overlap between the execution and the monitoring process. For CAL 1, Ambiente Italia (AMBIT) is responsible for conducting the co-design processes in four pilot green roof projects as well as online workshops, which helped to collect initial pre-greening data from November 2020 onward. For CAL 2, Eliante (ELI) together with MiloLab (a community

association) were responsible for survey dissemination as well as conducting interviews and collecting data from site visits and co-design participants, which started in September 2019. For CAL 3, the Municipality of Milan (CDM) in conjunction with jurisdiction 5 and 6 Municipalities, conducted a public consultation with RFI and Italferr about the Tibaldi train stop in December 2019. This work later moved to online platforms and focused mainly on an online co-design survey that commenced in June 2020.

3. Methodology

The co-production process of this mixed-method social monitoring framework was based on several steps, see Figure 1: (1) scoping and gathering information: what aspects are to be measured related to the social impact of NBS in a Milanese context; (2) developing the theoretical model and scientific triangulation: why specific aspects are measured; (3) verification workshops with partners: how to measure specific impacts for each case; (4) scientific iteration and testing of the methodology through questionnaire development: developing a baseline and database for an online depository; (5) launching the questionnaires to a wider public and collecting pre-greening data from questionnaires; (6) data elaboration for specific CALs' place-based situations.

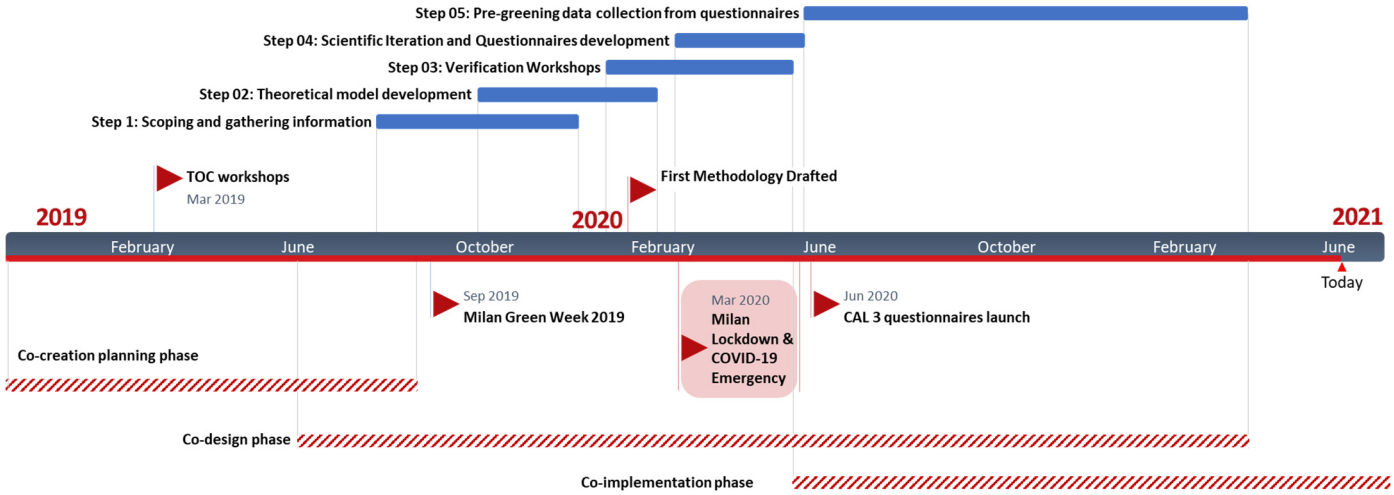


Figure 1. Timeline of the development for the Social Monitoring Methodology and the different steps presented in the work. Source: the first two authors.

Since the topic of this article is quite new amongst to the deduced similar methodologies [45–47] produced in this area of academic research, the efforts in selecting indicators were mainly related to the general aim of the project in using NBS to increase inclusiveness and strengthen collaboration between cities and citizens as seen in CLEVER Cities guidelines. The first step of the scoping activity of this methodological framework included gathering information on the three regeneration challenges related to social co-benefits of NBS.

The second step was complemented with a grey literature search for analogue indicators that have possible links with place-based connectedness to nature, NBS co-benefit measurements, mainly addressing wellbeing, psychosocial issues and social cohesion, but also considering safety and security, see Table 1. A series of internal team validation workshops were necessary to focus on regeneration challenges 1, 3 and 4 collectively in all three CALs between March and September 2019. In this step, the transformation of the ToC results into possible KPIs relative to each CAL place-based context was carried out by restructuring a logic and coherent chain from assumptions of the current situation into outputs and expected impacts that could be measured. Particular attention was paid to the Milanese context from earlier ToC workshops held for each CAL in March 2019, as well as

site observations and visits during co-design workshops in relation to the main impacts identified, (Figure 2a–d).

During the third step, progress towards the development of the theoretical model and the scientific validation of possible similar research methodologies was achieved. The resulting indicators were in the majority divided into one of these five macro categories.

Table 1. A summary of identified challenges and considerations from literature review carried out by POLIMI, DAStU.

Regeneration Challenges Identified by the Project	Topics (Macro Category Resulting from ToC in Milan Social Monitoring Framework)	Integrating Approaches Linking Social Impacts and NBS Co-Benefits (Leading to Micro Indicators in the Milan Framework)	Relevant Literature *
Regeneration challenge 1: Human Health and wellbeing	Relationship with nature and well-being related to NBS	Human wellbeing and general health Positive impact of greenery on environmental values and general aesthetics	[48–53]
	Use of space (leisure, sport, relax, outdoor activity, etc.)	Connectedness to nature and wellbeing Frequency and use of spaces Effect of COVID-19 change to use of space *	[54–63] *
Regeneration challenge 3: Social cohesion and environmental justice	Perceived ownership of space and place satisfaction	Satisfaction with the building characteristics and proximity to green areas relationships Perceived ownership of green areas	[13,64–67]
	Psychosocial issues and social cohesion	Social interactions, support and cohesion Place identity and sense of belonging Civic participation and willingness to participate in co-design activities	[25,68–72]
**Regeneration challenge 4: Citizen safety ** **	Citizen perception about safety and security	Increase in safety and security perception related to lighting, accessibility, maintenance, aesthetics, and interactions in places with the presence of other people	[73–75]

* These references were mainly identified during the course of the social monitoring methodology development timeframe from March 2019 till June 2020. Afterwards, some relevant literature also evidenced the social impacts generated from NBS, following the COVID-19 pandemic period. Henceforth, an additional set of micro indicators and survey questions were added to measure the use of green spaces during the lockdown period and its impact on perception related to relationship with nature and wellbeing, as well as to measure interest in participation in the co-maintenance aspects on the CALs of Milan. That was after the launch of the CAL 3 questionnaire in June 2020 which was the first pilot project. Hence in CAL 3, the indicators related to COVID-19 use of space were not measured for the pre-greening phase but will be monitored in post greening. ** POLIMI was the responsible partner for developing the framework of possible KPIs related to this regeneration challenge for the three CLEVER Cities project Front Runner Cities, see Appendix 02 in Supplementary materials. A Scientific master thesis was developed under the responsibility of Morello and Mahmoud in 2020, see [75].

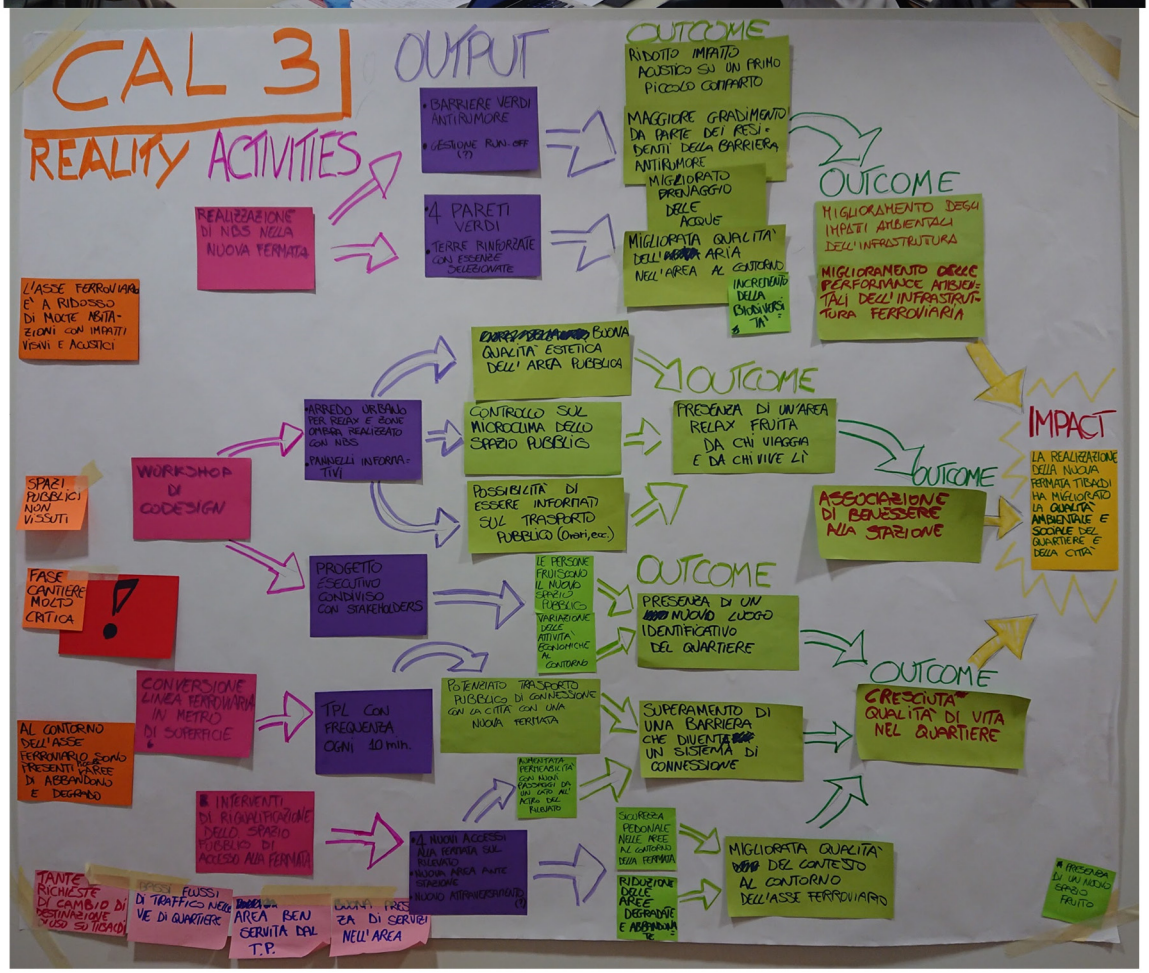
During the fourth step, the scientific iteration and testing of the methodology through progress questionnaires took place. Two main partners carried out this process, POLIMI and ELI, working collectively on the three different CALs. The development of the questionnaires took place across different formats (online and offline) and in two languages (Italian and English) initially. All versions and elaborations on the questionnaires were collaboratively shared with other partners in the LMT such as AMBIT for CAL 1, MiloLab for CAL 2, RFI and Italferr for CAL 3. A testbed carried out by the local CAL 2 team and MiloLab together with a small group of local stakeholders helped develop a baseline (19 answers), which was stored in a POLIMI database (online repository). In order to correlate the spatial impact of NBS on the beneficiaries of each CAL, two other sections (macro categories) were added to the social monitoring methodology and the questionnaires after this iteration, looking specifically at the relative knowledge about CLEVER interventions and expectations related to NBS co-benefits and socio-demographic data.

The fifth step started with launching the CAL 3 questionnaires online to the public in June 2020, together with an online campaign that was created with the help of the CLEVER Milan social media team and the website was prepared by the local team. This wider public launch and data collection step helped the scientific triangulation of some indicators and questions that, afterwards, were considered of critical importance in the other CAL 1 and

CAL 2 questionnaires. This helped ensure some cross-comparability in the local Milan context.

The last step is demonstrated in Sections 5 and 6 in data collection, analysis, results and discussions.

(**a**)



(**b**)

Figure 2. *Cont.*

(**c**)

(**d**)

Figure 2. Different focus groups and workshops to validate the needs to monitor specific aspects in the three different CALs. From top to bottom: (**a**) ToC workshop with local stakeholders, March 2019; (**b**) A typical panel of ToC, specifically here CAL 3; (**c**) Co-design by immersion activity in CAL2, September 2019; (**d**) Milan Green Week press conference by CDM, FPM, POLIMI, ELI, AMBIT and WWF, September 2019.

3.1. Implementing the Methodology in Practice

In order to create a mixed-method approach for this evaluation process, the assessment framework is structured as a matrix. *Horizontally*, it is based on the macro-and micro indicators that are relevant to the three general regeneration challenges previously mentioned. Then, the macro categories that relate to the main outcomes to be measured in each specific CAL were added. *Vertically*, the framework is divided in different sections, as follows:

1. Who: the target groups of the analysis that will benefit from the NBS intervention,
2. How: the measurement tools (quantitative surveys, and qualitative interviews),
3. What: the needs of each CAL (if the indicator itself will be evaluated in specific CAL),
4. When: the stage this measurement should be addressed (pre-greening or post-greening), and
5. The type of questions: descriptions of the type of questions to be utilized (binary, ranking using Likert scale, multiple choice questions, or open-ended).

Following horizontally, each macro-category has micro-indicators underneath that correspond to a specific section transferred from the survey template developed from April 2020 onwards (Appendix 01 in the supplementary materials). In the "What" columns, the options given to measure each micro indicator in each CAL were given by adding a drop-down button. This will ensure that the same question is being elaborated and the question number is added next to it for easier reading of the matrix.

In the following Figure 3, a simulation using this methodological tool was run for the CALs of Milan, see original tabular tool in supplementary material. Taking into consideration the different timelines of the application of the questionnaires in the three CALs and the timeline of step 05 as explained in Figure 1, a set of indicators was identified on the horizontal axes in order to facilitate the cross-comparability between the results obtained and the data analyzed. The results from this simulation have shown the most important micro indicators to focus on, as below:

- Relationships with nature, wellbeing related to NBS and the use of space.
- The perceived ownership of space by different groups together with place satisfaction.
- Psychosocial issues, such as social cohesion, place identity and the focus on a sense of belonging towards the NBS in area of intervention.
- Knowledge about CLEVER Interventions and participation in community activities related to NBS.
- Citizens perceptions about the interventions in terms of safety and security related aspects.
- Socio-demographic data related to the area of intervention.

MACRO/MICRO indicators	Target groups			Measurement tool				where						when		Question
analysis of demographic data will consider: age, sex, residence vicinity, interest in the area of intervention in all monitoring periods.	**these are indications for the sample of the respondents to be gathered during all monitoring periods.**			**quantitative**		**qualitative**		**CAL 1**		**CAL 2**		**CAL 3**		**#**	**#**	**type**
These target groups should be diversified and balanced in age, gender, race (if needed) and include sample of social-level outcomes and all different vulnerable groups	stakeholder	residents	other specific groups	surveys on/off	on site observations	interviews stakeholders	focus groups	GRW	qn#	GIAM129	qn#2	TIBALDI	qn#	pre	post	
1. Relationship with nature and well-being related to NBS in the area of intervention																
1.1 Relationship with nature and well-being related to NBS																
importance of the green as a priority in the neighborhood/ area of intervention	yes	yes	*NA*	yes	no	yes	yes	yes	19	yes	13	yes	8	yes	yes	scale
positive impact of the green areas in your neighborhood/area of intervention (health and well-being, environmental values, air quality, biodiversity, heat in summer, aesthetics of surroundings, social cohesion and relationships)	yes	yes	*NA*	yes	no	yes	yes	yes	20	yes	14	yes	12	yes	yes	ranking
did the recent emergency crisis change the use and perception of green spaces	no	yes	*NA*	yes	no	yes	yes	yes	22	no		no		no	yes	binary
2. Place, use of space and connectedness to Nature																
use the green areas around you or in your neighborhood (frequency of visits)	no	yes	*NA*	yes	yes	yes	yes	yes	21	yes		no		yes	yes	binary
type of use for the green space (leisure, sport, social, relax, outdoor activity, etc.)	no	yes	*NA*	yes	yes	yes	yes	yes	7	yes	6	yes	1	yes	yes	multiple choice
Time of use / work/ living in building/ neighborhood / area of interest (COVID)		yes	*NA*	yes	no	no	no	yes	10	yes	22	no		no		binary
Frequency relationship time with building/ neighborhood/ area of intervention	yes	yes	*NA*	yes	no	no	no	yes	9	yes	8	yes	34	yes		binary
Activities usually carried out in the place (multiple answer)	no	yes	*NA*	yes	no	no	yes	no		yes		yes	3	yes		multiple choice
3. Perceived ownership of space and Place satisfaction																
3.1 Place Satisfaction (general residential, open space or building)																
satisfaction with the neighborhood where you live (in case of large scale intervention)	yes	yes	*NA*	yes	no	yes	yes	no		yes		no		yes	yes	binary
overall satisfaction with the building where you live (increase of green roofs and walls)	yes	yes	residents of same building in CAL 1 in pre-post	yes	no	yes	yes	yes	14	no		no		yes	yes	binary
General satisfaction with the NBS/green area of intervention around where you live (in case of urban gardening, urban parks and green noise barriers)	yes	yes	commuters in CAL 3	yes	no	yes	yes	yes	23	yes	24	no		yes	yes	binary
Place Satisfaction with the building characteristics (thermal comfort, landscape, aesthetics [of buildings] sound environment, lighting , availability of common spaces, local services and amenities, quality of public areas, accessibility to green spaces)	yes	yes	residents of same building in CAL 1 in pre-post	yes	no	no	no	yes	15	yes	12	yes	7	yes	yes	scale
4.Psychosocial issues and Social cohesion																
4.1.Social Interaction and cohesion																
Social interaction, support, and cohesion (asking a favor, trust people in neighborhood, asking for help, getting along, people bond from different backgrounds, happy with relationships)	yes	yes	same participants in pre-post	yes	yes	yes	yes	yes	13	yes	11	yes	6	yes	no	scale
talk with neighbours apart greetings	no	yes	same participants in pre-post	yes	no	yes	yes	yes	11	yes	10	yes	4	yes	no	binary
4.2.Place identity and sense of belonging																
evaluate sense of belonging to the building/ neighborhood/ area of intervention	yes	yes	*NA*	YES	no	no	yes	yes	8	yes	7	yes	2	yes	yes	binary
5. Citizen perception about safety and security																
5.1 Lighting and clear visibility																
the area is lightened, visually clear paths, no sense of fear is perceived	yes	yes	*NA*	yes	yes	yes	yes	yes	29	yes	27	yes	26	yes	yes	ranking
5.2Accessibility to green area																
increase of accessibility means in the area (walkability, bikeability, physical activities, etc.)	yes	yes	*NA*	yes	yes	yes	yes	no		yes		yes	26	yes	yes	ranking
5.3 Maintenance of green area																
status of the green area (litter, green condition, furniture, etc.)	yes	yes	*NA*	yes	yes	yes	yes	yes	34	yes	27	yes	26	yes	yes	ranking
Difficulty of maintenance (high cost and technical errors) / vandalism, degradation	yes	yes	*na*	yes	no			yes	34	yes	28	yes	27	yes	no	scale
5.4 Aesthetics																
green increase aesthetic quality of the area (green roof, walls, parks, etc.)	yes	yes	*NA*	yes	no	yes	yes	yes	34	yes	27	yes	26	yes	yes	ranking
5.5 Activities and presence of other people																
interaction in spaces, variety of activities, stickiness to places help you stay	yes	yes	*NA*	yes	yes	yes	yes	yes	29	yes	27	yes	27	yes	yes	ranking
6.Knowledge about CLEVER Cities project and interventions																
Knowledge about clever project	yes	yes	*NA*	yes	no	no	no	yes	24	yes	30	yes	9	yes	no	binary
what do you know about clever interventions	yes	yes	*NA*	yes	no	no	no	yes	25	yes	31	yes	10	yes	no	open ended
Knowledge about NBS in general	yes	yes	*NA*	yes	no	no	no	yes	26	yes	32	yes	11	yes	no	open ended
Knowledge about Milan green roofs / shared gardens / green train stations	yes	yes	*NA*	yes	no	no	no	yes	27-28	yes	26	yes	23	yes	no	multiple choice
participation to co-design and co-management of intervention	yes	yes	*NA*	yes	no	no	no	yes	35	yes	29	yes	35	yes	no	ranking
7.Socio-demographic data Characteristics																
sex/gender	yes	yes	*NA*	yes	no	no	no	yes	2	yes	1	yes	28	yes	yes	binary
age	yes	yes	*NA*	yes	no	no	no	yes	3	yes	2	yes	29	yes	yes	binary
Laboral situation	yes	yes	*NA*	yes	no	no	no	yes	5	yes	4	yes	31	yes	yes	binary
Education	yes	yes	*NA*	yes	no	no	no	yes	6	yes	5	yes	32	yes	yes	binary
Legend		Macro indicator			Micro indicator		*NA*	yes	d as is			no	losed			
	QWERTY	sample of question explanation														

Figure 3. Simulation of the Methodological tool for social monitoring framework, source: the first author. A copy from the tabular tool is provided in supplementary material (methodology Excel sheet).

On the vertical axes, the most common target groups are the residents for all indicators. The most common measurement tool turned out to be the surveys, both online and offline, followed by interviews with local stakeholders and focus groups. However, the latter two instruments are less relevant since they might be not resident or completely familiar with the context with respect to the Macro categories related to place satisfaction, CLEVER interventions, and socio-demographic data analysis. In general, the macro indicators and most measurement tools are mainly to be used collectively in CAL 1, CAL 2 and to some degree in CAL 3. Hence, a combination of quantitative surveys and qualitative interviews were considered for complementary assessment, also, as in the ToC approach, to set a socio-economic framework that can support final decision-making for NBS.

The highlighted areas (red rectangles) in the Figure 3 below show how the overall selection of the target groups for the questionnaire's distribution and the measurement tool for the analysis was evaluated. In addition, the highlighted areas show the exact CALs where the simulation of the overall methodology was built-upon and on which indicators this was focused.

3.2. Some Notes on the Methodology and the Questionnaires' Form

The methodology is meant to be transversal to all three CALs in Milan in order to coordinate and better understand if some of the survey structures could be identical and allow some comparability in results between different CALs. However, we understand that the rest of the Front Runner cities do not necessarily have the same macro thematic categories for social interaction and cohesion related to NBS interventions impact, and that the results are not comparable to the other frontrunner cities. However, it is also a flexible tool that has the ability to change the macro categories in order to replace them with whatever other themes or macro indicators are needed for the specific context.

An on-site, visual observation tool is also considered highly important in providing more insight on the actual status. However, it may not be used for some indicators in order to avoid bias of the observers, as much of the observation work is referred by CLEVER Cities team and not easily transferred to outsiders. Nonetheless, it is highly relevant to the type of green space use and the activities people carry out in the space itself. It is then recommended in the post-greening phase evaluation as a key measurement.

For the pre-greening phase, we started drafting an online survey that has the same macro-category and then translated each micro-indicator into a type of question as indicated in the last column, respectively. Some questions have then incorporated a more complete list of elements to be evaluated based on the status of the CALs. The survey was initially pre-tested with people from the local community and residents not involved in the methodology design to assure the questions are convenient to respond to, clear, and easy to understand.

The CALs in Milan then required a more in-depth interview form using the same methodology as the macro/micro-indicators structure; however, the queries have more open-ended questions with relation to pre-greening and post-greening phases. The analysis of these interviews is still to be completed and will be included in the future research undertaken after the post-greening phases.

4. The Case Study of Milan CLEVER Action Labs

Before the analysis of the collected data from the surveys, in the following section we give an overview of the three CLEVER Action Labs (CALs) [76]. The CLEVER Cities Milan project area is situated in the south of Milan. It has three CALs, two spot interventions (CAL 2 and CAL 3) and one extended area (CAL1) mainly in the south part of the city, (Figure 4). In the local context, CdM, AMAT, AMBIT, ELI and POLIMI are responsible for collaboratively promoting urban greening measures such as NBS in terms of policy, planning, design and implementation.

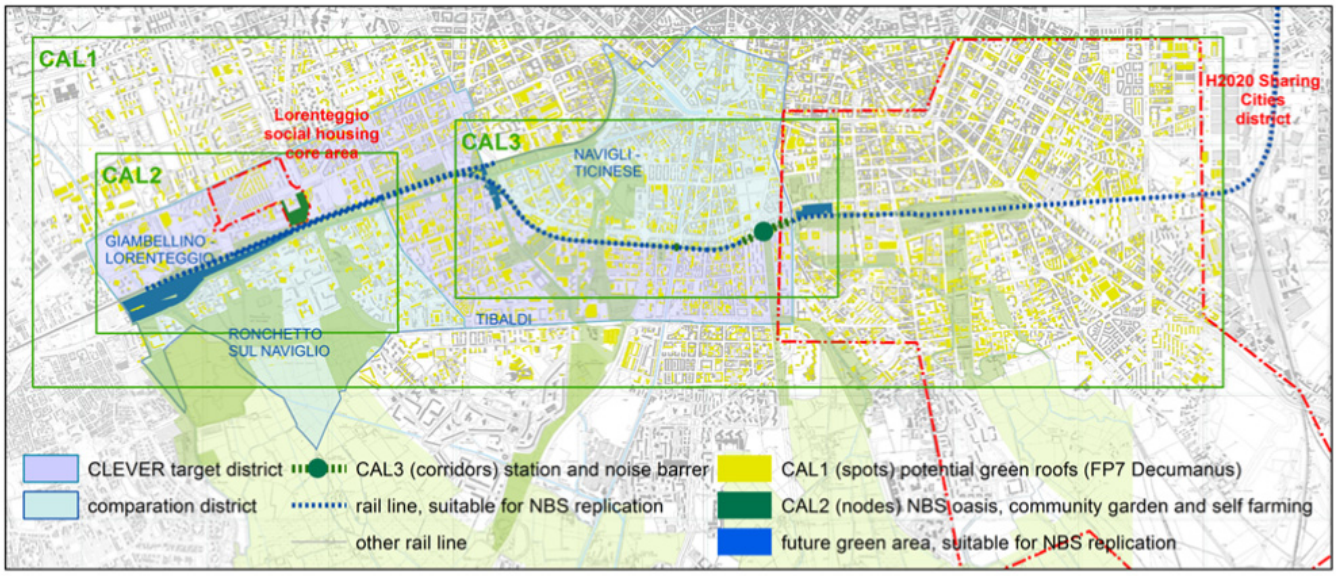


Figure 4. Territorial operating area of the CALs of Milan, southern transect. Source: the CLEVER Milan team, GA—June 2018.

The work being conducted in CAL1 has influenced policymakers to incorporate these urban greening measures (NBS) into the New Building Code of Milan (Regolamento Edilizio del Comune di Milano 2021, see https://www.comune.milano.it/aree-tematiche/urbanistica-ed-edilizia/sportello-unico-edilizia/regolamento-edilizio-del-comune-di-milano accessed on 19 July 2021). Moreover, the CAL 1 is focused on mainstreaming green roofs and walls to raise wider awareness of their benefits, to increase the overall amount being installed, and to encourage professionals and companies to embrace their use as part of their own approach [77].

The CAL 2 and CAL 3 are located in deprived areas, heavily affected by the railway infrastructure that crosses them. The CAL 2 is situated in a densely built-up area that is mostly residential, and it is focused on the neighborhood Lorenteggio Giambellino. Whereas CAL 3 comprises the area where the new railway stop Tibaldi is being constructed.

In CAL 2, ELI with CdM and AMAT are transforming the fragmented neglected areas near railway tracks into spaces for community farming that will serve as natural oases to increase community cohesion and improve storm water management. In CAL 3 with RFI, ITALFERR, CdM, AMAT and ELI, the local partners are developing new types of noise barriers using NBS that include interventions to strengthen biodiversity aspects and mitigate environmental impacts from the Tibaldi railway station.

Each CAL applies different modalities to mobilize public and private resources. CAL 1 is testing how the co-creation process can help raise private funds to complement and facilitate municipal funding. Based on the current development of activities, CAL 1 has progressed slightly at an advanced rate in terms of planning and co-implementing activities. This is because their successful implementation was subject to a complex structure of arrangements that involved different stakeholders, respectively their time availability, organizational capacity and technical assistance provided for CAL 1 activities.

4.1. CAL 1: Regreening Milan Green Roofs and Walls

The focus of CAL 1 (Figure 5) lies on the design and promotion of innovative NBS, such as the experimental and multifunctional green roofs and walls. To promote NBS, CAL1 has been developing an awareness-raising campaign. Its goal is not solely to increase knowledge about the importance of greenery in our buildings, but also to adopt a more strategic approach to public interest communication. It aims for the translation of this awareness into action, such as triggering a legislative change or supplementation,

and helping drive professionals to employ green roofs and green walls in their building practices.

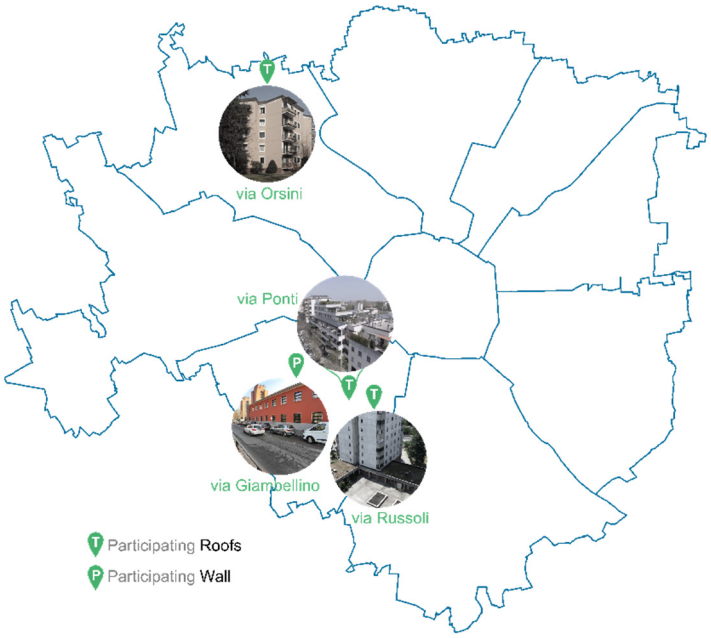


Figure 5. CAL 1, operating four green roofs and walls in Milan, source: AMBIT, May 2021.

Given the aforementioned objectives of this CAL, the activities were defined in two main tasks on which they will work:

- Increasing the knowledge through engagement and dissemination activities; i.e., the awareness-raising campaign.
- Turning knowledge into action in the form of the CLEVER pilot projects (green roofs and walls).

As part of the awareness-raising campaign, the activities carried out were related to knowledge exchange. These included two guided tours to discover green roofs and walls in Milan (one right after the CAL 1 launch on the 14th of June 2019 and the other one during the Milano Green Week, September 2019), three training courses on "Green Roofs and Walls" (in October 2019), and to disseminate knowledge during Milano Green Week, including a mobile exhibition that travels to different events and explains the important benefits of the CLEVER Cities project.

The second task of CAL1 initiated with the procurement process. The role of AMBIT, together with the CDM, was to advance the co-financing schemes for the implementation of the CLEVER pilot projects. In the subsidy scheme set for this purpose, two public calls have been launched. One for the selection of 10 potential green roofs and walls that will apply for 35% subsidy and technical support for NBS co-implementation, and another for the identification of experts skilled in designing green roofs and walls, who will provide the technical support through a co-creation process in the CLEVER Cities framework [78].

Due to the many consequences caused by the COVID-19 emergency, mostly in relation to the financial availability of resources, six of these projects that initially confirmed their interest in co-creating green roofs and walls have withdrawn their applications. With some delays, the co-design for the remaining four projects has started, which have also been subject to social monitoring in the pre-greening phase as in this article scope. The questionnaires for social monitoring of the four participating projects (via Russoli, via Orsini, via Giambellino, and via Ponti) have been submitted simultaneously during the co-design workshops. As explained below (Section 5.1—data collection), the compilation was carried out online and with technical assistance from co-design teams.

4.2. CAL 2: A Community Park in Giambellino, 129. Milan

The focus of CAL 2 lies on creating a new community garden, in the public area located in Giambellino 129, previously abandoned and with contaminated soil (Figure 6). The green area in G129 could be considered a steppingstone in the green ecological network on the Milan Circle line railways side [79]. Surrounding the social housing neighborhood of Lorenteggio-Giambellino is a dense residential area with a strong need for (and lack of) green and shared spaces. The old social housing block needs to be rehabilitated, which will be realized in the coming years by the Lorenteggio Suburban Rehabilitation Programme' s Masterplan and the Peripheries Rehabilitation Plan of the Municipality. The social context is complex: Lorenteggio's population is mainly composed of elderly residents and migrants from different countries (the latter category 40% of residents in 2015). The degradation of some social houses causes crimes and conflicts; hence, a lot of people perceive a sense of insecurity and lack of safety.

Figure 6. CAL 2, Giambellino 129 Community public park, co-designed with residents from the neighborhood, authorized use from the CDM—published on CLEVER Milan website, April 2020.

However, Lorenteggio has a strong local community that is active in many initiatives to promote social cohesion and citizen engagement, working together towards a better use of urban spaces. The co-creation process implemented by MiloLab, and the CLEVER Cities project aims to encourage citizens and local organizations to co-design, co-manage and co-monitor the new community garden. Different types of NBS have been designed to create a high-quality multifunctional green space that focuses on enhancing connectedness and relationship to nature as well as social cohesion. Examples of these projects include a bird garden, an orchard, a community garden and a butterfly garden. The overall aim of this CAL is to provide a high-quality multifunctional green infrastructure in Giambellino 129 that can enhance presidium, social cohesion and ecological values. In particular, the social monitoring activities of CAL 2 include the evaluation of the impact associated with the new area on wellbeing and quality of life, social cohesion and sense of belonging.

4.3. CAL 3: A New Train Stop in Tibaldi

CAL 3 focuses on the opportunities arising from the construction of the new Tibaldi railway stop (See https://www.tibaldiscarl.it/presentazione/2.html [in Italian, accessed on 20 April 2021]) by working on a threefold program: improving the stations' environ-

mental performance (rainwater management, microclimate and thermal comfort for the travelers), allowing the continuity of the ecological corridor for biodiversity and introducing groundbreaking standards that would incorporate NBS for noise mitigation. The experimental integration of NBS in railway infrastructure is in line with the principles of the European Union strategy on Green Infrastructures to help enhance health, wellbeing, provide jobs and deliver many benefits from nature to citizens [80].

In line with the program and within the CLEVER co-creation framework, the co-design of the public square, in front of Tibaldi's railway stop, has been supported by several activities. An internal focus group has initiated the design of the project (September 2019) which afterwards was presented and opened for public discussion (July 2020). Due to the pandemic context, a questionnaire on co-design was conducted (10 November 2020–31 December 2020) in which a significant number of local citizens participated (no. 325) (https://milanoclever.net/2021/04/28/risultati-sondaggio-cal3-tibaldi/ [in Italian, accessed om 20 April 2021]). This questionnaire aimed to engage the local citizens in the co-design process by giving them the opportunity to choose the functions, urban furniture, tree and plant species and paving materials. The co-design phase also foresees the engagement of technical NBS experts, with whom a workshop was organized in January 2021. Besides the public space that serves as an "open-air waiting area" of the railway station, the project also encompasses a number of NBS such as green walls, green railway embankments, and green noise barriers (Table 2).

Table 2. ToC Summary table for CALs interventions in Milan related to social monitoring framework, source: the first two authors, elaborated from ELI and AMB.

	CAL 1	**CAL 2**	**CAL 3**
Brief Description	Green Roofs and Walls	A Community Public Park	An Open-Air Waiting Area
CLEVER identified Regeneration Challenge	Regeneration challenge 1: Human Health and wellbeing	Regeneration challenge 3: Social cohesion and environmental justice	Regeneration challenge 4: Citizen safety and security
Aims and expected outputs related to ToC	Better training of citizens in workshops New financial partnerships	Soil restoration Citizen Engagement in co-design activities	Changes to planning policies related to NBS
Expected Outcomes	Higher availability of green roof spaces Increased sense of belonging and social wellbeing Increased quality of built environment	Increased Biodiversity * Increase of citizens awareness through co-monitoring of Nature-based solutions	Reduction in Crime Reduction of acoustic noise from the stationIncrease sense of belonging towards the neighborhood of interventions
Specific Micro Indicators	Increase connectedness to Nature and aesthetics	Increased social cohesion and support	Increase in sense of safety and security
Expected Measured impact from social monitoring framework	Greener urban spaces generate higher wellbeing for residents and better environmental quality	A higher quality multifunctional green infrastructure with community involvement and social presidium	A new railway stop, with higher social and environmental quality for the surrounding neighborhood and city

* Beginning in summer of 2021, biodiversity measurements in CAL 2 will be collected with similar methods of observation, community walks and focus groups, but will use separate sets of indicators in LMP, apart from these social monitoring framework purposes.

5. Data Collection, Analysis and Results

To simplify the process of adapting this social monitoring framework for the comparative analysis of this research article, the following micro indicators (Figure 7) were selected transversally from the three CALs to be analyzed commonly to build on the different aspects of the Milano context case study. They are as follows:

- Relationship with nature and wellbeing related to the NBS intervention (Regeneration. Challenge. 1)
- Positive impact of greenery on environmental values related to the neighborhood (Regeneration. Challenge. 1)
- Connectedness to Nature and use of space (leisure, sport, relaxation, outdoor activity, etc.) (Regeneration. Challenge. 1)
- Place satisfaction (general residential, open space or building), (Regeneration. Challenge. 3)
- Social interaction and cohesion within the place (Regeneration. Challenge. 3)
- Place-identity and sense of belonging (Regeneration. Challenge. 3)
- Citizen perceptions and concerns on safety and security of NBS interventions (Regeneration. Challenge. 4).

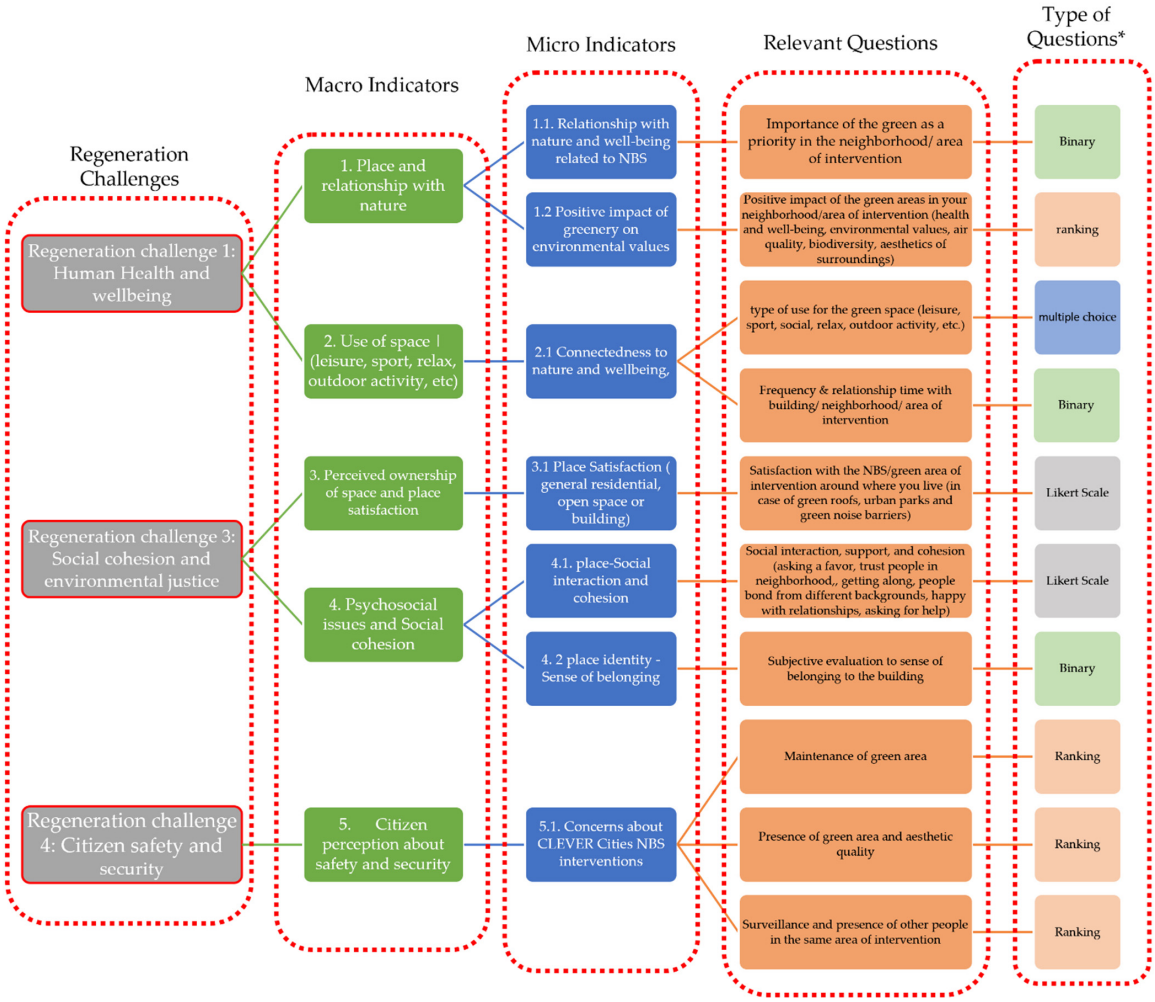


Figure 7. Tree map of the selection of relevant macro categories and micro indicators for the analysis of questionnaires, as well as the type of questions *. Source: the first author. * Referring to the type of questions: binary is mainly yes/no questions; Likert scale is mainly based on exhaustive mutual scale of preferences; ranking questions are prioritized ranking to questions with relevance or preferences; multiple choice questions refer to different possible choices within the available answers to select.

Another two sets of micro indicators were added to these previous ones not uniquely related to the urban regeneration challenges of the CLEVER Cities project, but rather to the city-specific CALs context, after the iteration described in Step 04 (Figure 1). They measure the following points:

- Knowledge about the CLEVER interventions and NBS in general in the city of Milan, in addition to the willingness to participate in co-design and co-management of CLEVER interventions.
- Socio-demographic data (gender, age, labor situation, and educational level).

All relevant questions recorded in Figure 7, have been tested and checked with local stakeholder groups from CAL 2 (19 answers) before the official launch of the questionnaires to confirm common question types (binary, Likert scale, ranking, multiple choice or open-ended questions). In the online Italian questionnaires, the order of the sections and certain relevant questions were alternated in order to avoid bot fraud and to lessen online monotony for the respondents due to its total length (average 35 questions).

5.1. Data Collection

The data collection was divided into a few phases, and it lasted approximately one year, from May 2020 until May 2021. Table 3 summarizes the initial start and end dates of the data collection as well as the status of the pre-greening questionnaires. According to the aforementioned methodology, all pre-greening questionnaires were designed to contain approximately 35 questions in total, with an expected maximum of filling-in time of 20 min. These constraints will also be considered for data collection during the post-greening phase since they have been developed in concordance with other Front Runner cities of the CLEVER Cities project.

Another relevant note on data collection between March 2020 and March 2021 is that the general use of online questionnaires by different municipality departments was gaining popularity from a wider public consensus; hence its major use during the pandemic emergency. Nonetheless, to avoid digital divide and marginalization of vulnerable populations, a dedicated team from ELI and AMBIT was following onsite data collection through paper questionnaires and assisted in compilation of the forms.

Table 3. Data collection target groups, timelines and methods of dissemination.

#	Target Groups	Timeline	Methods of Dissemination	Average Time Elapsed	Number of Respondents
CAL 1	People who live or work in the buildings where the green roof/wall will be built	November 2020–May 2021	Online + on site assisted compilation (in Via Russoli and Via Ponti)	36:45 * Min	79
CAL 2	Stakeholders who took part in the participatory process of co-design of G129	May 2020–October 2020 (Limited distribution within the MiloLab and co-design participants)	Online + on site assisted compilation	23:36 Min	19 ***
	Inhabitants or frequenters of Giambellino neighborhood	March 2021–April 2021 ** (Wider distribution with municipality newsletter)	Online + on site assisted compilation	19:07 Min	167
CAL 3	Inhabitants or frequenters of Tibaldi neighborhood	June 2020–September 2020	Online	19:36 Min	92
		Total			338 ***

* In CAL 1, one answer was recorded during an extensive elapsed time (24 h) due to a human error and it artificially raised the average elapsed time, substantially. ** In CAL 2, a wider online and offline campaign was carried out between March and April 2021 in order to include a younger age range in the analysis. This was in response to the predominance of older age categories noticed during the initial phases of data collection. *** The initial testbed questionnaires are not analyzed in this research article since the need for this analysis is obsolete; it was needed to test the questionnaires flow, logical chain and progress time but does not add major statistical information to the results since it was conducted with local team members and a small group of stakeholders. Hence the total is 357 − 19 = 338 questionnaires analyzed. No sensitive data was collected during the questionnaire's submission. The LMT decision was to cover the ethical issues regarding the participation of people and their data, taking the consideration not to collect any personal information unless participants gave consent.

The population sample of the questionnaire's respondents were equally distributed among the residents and frequenters of the neighborhoods and eventually across possible age ranges and gender; however, in CAL 2, major interest from female residents was noted.

5.2. Data Analysis and Results

Cross-comparative analysis to the exclusively selected micro-indicators in this research, as explained before, was used to identify correlations between NBS interventions and perceptions related to NBS social impacts. The authors have related only the positive responses recorded from each question (Table 4). The reason for this decision is that the final aim of this research article is to provide insight into simple quantitative analysis and methods to support NBS pre-greening procedures and the co-implementation phase [25,28,63,81–89]. Hence, the percentages or numbers reported below refer to the highest positive value recorded in each category: very important or very satisfied on Likert scale questions; yes (or only one category) in Binary questions; for multiple choice or ranking scales, the first four priorities are considered in the matrix.

Table 4. Cross-comparative analysis results from social monitoring impacts and questionnaires on perceptions. In bold, the highest % in each CAL vertically, the last column shows an averaged % evaluation for each indicator; in red, the most relevant. = <45% > 100% Positive high relation between Micro indicator and questionnaires results.

	MACRO Categories	MICRO Indicators	CAL 1	CAL 2	CAL 3	Indicator Evaluation
Regeneration Challenge 1: Human Health and wellbeing	1. Relationship with nature and well-being related to NBS in the area of intervention	**1.1. Importance of the green as a priority in the building or neighborhood of intervention in personal opinion**				
		Very important	80%	86%	87%	High
		1.2. Positive impact of the green areas in your neighborhood/area of intervention in personal opinion				
		Aesthetics of the neighborhood or buildings	55.7%	65.3%	48.9%	High
		Citizen's health	53.2%	60.5%	52.2%	Medium
		Citizen's well-being	49.4%	65.9%	57.6%	High
		Perceived temperature and thermal comfort	45.6%			Low
		Air quality	45.6%	70.7%	53.3%	High
	2. Place, use of space and connectedness to Nature	**2.1 Type of use for the building or neighborhood relationship**				
		Living in the same building or Neighborhood	65.8%	80.2%	72.8%	High
		Working in the same building or Neighborhood	26.5%	4.1%		Low
		Frequenting cultural activities in the neighborhood		8.3%	8.6%	Low
		Visiting for green areas or physical activity in the neighborhood		23.3%	15.20%	Low
		Other or personal reasons (family or friends)	7.5%	11.9%	35.8%	Low
		2.2. Frequency relationship time with building/ neighborhood/area of intervention				
		More than 5 years	84%	82%	84%	High
Regeneration challenge 3: Social cohesion and environmental justice	3. Perceived ownership of space and place satisfaction	**3.1. Place Satisfaction with the building or neighborhood characteristics**				
		Accessibility to parks and green areas	82%			High
		Maintenance and Cleaning of the area	67.2%			Medium
		Availability of common spaces	63.3%			Medium
		Economic accessibility and services prices		43.7%		Low
		Public services availability		62.90%	64.1%	Medium
		Environment and Landscape attributes		19.8%	48.9%	Low
		Transportation and logistics			64.2%	High
		Aesthetics of the neighborhood or buildings	62.5%			Low
		The neighborhood in general		25.7%	49%	Low
	4. Psychosocial issues and social interactions	**4.1. Place Social interaction, support and Cohesion**				
		Staying Long in this Building /Neighborhood	74.3%	71.8%	67.1%	High
		Happy with relationships and vicinity in this building/neighborhood	76.%	64.70%	69.70%	High
		Exchange favors and things with the residents	59.50%	49.70%	52.80%	Medium
		I know people that I can ask for help and support			64.80%	Medium
		I trust people in my neighborhood	53.90%	38.30%	51.10%	Medium
		4.2 Place identity and sense of belonging				
		Very strong sense of belonging	81%	71%	76%	High
Regeneration Challenge 4: Citizen security	5. Citizen perception about safety and security	**5.1. Concerns about CLEVER Cities NBS interventions related to the building or the neighborhood**				
		Lighting and clear visibility		56.30%	71.70%	High
		Accessibility pedestrian and Cycling		34.10%	67.40%	Medium
		Maintenance	42.40%	64.70%	81.50%	High
		Presence of green areas	84.80%		48.90%	High
		Aesthetics	84.80%	29.30%	41.30%	High
		Presence of other people in space	62%	29.90%	45.70%	Medium
		Presence of security personnel and surveillance	36.80%	37.10%	69.60%	Medium

Knowledge of the CLEVER Cities Project and socio-demographic analysis are presented afterwards (Table 5), hence providing evidence of a clear relationship between the three main regeneration challenges of the project with evidence-based data on general knowledge of NBS and social structures in the three CALs specific contexts.

Table 5. Cross-comparative analysis results from the socio-demographic data in three CALs and knowledge about CLEVER Cities interventions. In red, the most prominent categories.

	MACRO Categories	MICRO Indicators	CAL 1	CAL 2	CAL 3	Indicator Evaluation
City specific CALs context	Knowledge about CLEVER Cities interventions	**Information about CLEVER Cities project and NBS**				
		Knowledge about CLEVER Cities project generally before the questionnaire	29.0%	20.0%	23.0%	Low
		Knowledge about Milan green roofs/shared gardens/green stations respectively	48.6%	47.0%	68.5%	Medium
		Willingness to participate in co-design and co-management of intervention				
		I want to be more informed about how the roof/wall will be built in the building or Neighborhood where I live/work	64.6%	80.0%	84.4%	High *
		I want to collaborate in the co-management and co-maintenance of the green roof/wall in the building or Neighborhood where I live/work	39.5%	20.0%	28.6%	low
	Socio-demographic data Characteristics	**Gender**				
		Male	57.0%	26.0%	46.0%	Medium
		Female	42.0%	74.0%	53.0%	High
		I prefer not to say	01.0%	0%	01.0%	low
		Age Range (% calculated over all respondents in each CAL)				
		16–24	1.3%	2.4%	4.3%	Low
		25–34	0.0%	9.0%	8.7%	Low
		35–49	21.5%	16.8%	21.7%	Low
		50–64	39.2%	32.9%	0.0%	Medium
		65–79	32.9%	36.5%	42.4%	High
		I prefer not to say	5.1%	2.4%	21.7%	Low
		Labor Situation				
		Unemployed	5.1%	2.4%	1.1%	Low
		Employee or self-employed/freelancer without employees	48.1%	44.3%	62.0%	High
		Self-employed with employees	1.3%	1.8%	3.3%	Low
		Retired	38.0%	37.7%	22.8%	Medium
		Household	1.3%	5.4%	2.2%	Low
		Not working—disability or long-term sick leave	1.3%	0.6%	0.0%	Low
		Student	1.3%	2.4%	3.3%	Low
		I prefer not to answer	1.3%	1.8%	3.3%	Low
		Education				
		PhD./Master	2.53%	6.59%	2.17%	Low
		University degree/Bachelor	10.13%	35.33%	51.09%	Medium
		High School Diploma	49.37%	46.11%	43.48%	High
		Middle School	25.32%	8.98%	2.17%	Low
		Elementary School	10.13%	1.80%	0.00%	Low
		No educational qualification	0.00%	0.00%	0.00%	NA
		I prefer not to answer	2.53%	1.20%	1.09%	Low

* A noticeable high willingness to participate in co-design and co-management of the activities and interest in information about the NBS interventions. Even though the initial knowledge about the CLEVER Cities project results are low, there is remarkable interest in information about Milan NBS. That interest is also reflected in a high number of subscriptions to social media channels and the local CLEVER Milan website, as respondents were invited to subscribe after submitting their questionnaires, in order to receive updates from the project.

In general, the cross analysis between the three different CALs gives insight into the Milanese territorial cohesion and stability in the relationship with the neighborhood where they live. Socio-demographic data reveal a major interest in public participation in co-creation activities as well as higher response values from females, generally in the age range of 50–79. Specifically, a noticeable percentage of the respondents were part of the mature population of 35–49 years (21.5%), 50–64 (32.9%) and 65–79 (36.5%). In addition, high rates of employees and self-employed (or freelance without employers) and retirement

categories were noticed, as well as a high rate of high school diploma respondents (46.32%), followed by university degree holders (32.18%).

6. Discussions and Conclusions

The results from the questionnaires give indications of the different social impacts of NBS interventions in urban environments and the correlation of the human relationship to nature. These impacts are related to the main co-benefits of improving general health and wellbeing, social interactions and cohesion, and an increase in the use of space, place satisfaction, connectedness to nature and safety perception. With particular focus on each regeneration challenge raised in the project, we can summarize the following on each indicator (see supplementary material):

- **Relationship to nature and improved wellbeing related to NBS intervention (Reg. Ch. 1)**

This indicator shows a collective consensus about green areas as a priority for all respondents (all CALs $\geq$ 80%). CAL 2 showed an internal correlation with the neighborhood or building since these 80% are all residents or daily frequenters of the same building for more than 5 years. CAL 3 showed an external correlation as a majority of respondents did not participate in the public introductory event by the municipality regarding the Tibaldi station in December 2019.

- **Positive impact of greenery on environmental values related to the neighborhood (Reg. Ch. 1)**

Noticeably, this indicator highlights the synergies between individualistic preferences such as health and wellbeing of citizens in comparison to general preferences related to neighborhood aesthetics or air quality and pollution in all the three CALs. The percentage shows the cumulative prioritization of the higher four selections in each CAL from the "strongly agree" response, with percentages $\geq$ 45% (In social studies, the general consensus is that correlation percentage is considered positive if above 47%.)

- **Connectedness to nature and use of space (leisure, sport, relaxation, outdoor activity, etc.) (Reg. Ch. 1)**

The answers reported in this indicator are mostly from respondents that have either a residential or labor relationship with the building (or both) and neighborhood where the NBS are built or realized. A high correlation between neighborhood residency and place satisfaction related to usage of green areas for leisure or physical activity is also noted in CAL 2 and CAL 3, respectively. In other words, the majority of the questionnaire's respondents are also from the same neighborhood, which is also due to the exclusivity in the questionnaire's distribution either online or offline, since the target population was the users of the buildings or neighborhoods where the CLEVER intervention will be carried out. While in all CALs the majority of participants have a residential relationship to the place, the second most frequent relationship is specific to each CAL: work in CAL 1 buildings, visit green area or do physical activity in CAL 2 community garden, and family and friends in CAL3 station.

- **Place satisfaction (accessibility to parks and green areas, maintenance and cleaning status), (Reg. Ch. 3)**

All high percentages in this indicator are referring to people with more than 5 years stable relationship with the same building or neighborhood. In CAL 1, 92% of these stable relationships have been either residents or high frequenters that visit the building at least once daily. In CAL 2, 86% of these stable relationships have selected the green areas in the neighborhood as very important for them from the first indicator on relationship with nature. In CAL 3, 94% of these stable relationships think the green areas of the neighborhood are very important.

- **Place-social interaction and cohesion (Reg. Ch. 3)**

A high satisfaction with their social interaction was noticed in all CALs. In CAL1 and CAL 3, valorization of social bonds, trust and support is also remarkable. Contrarily, in CAL 2, people in the neighborhood show a lower general satisfaction; nonetheless, residents are content with their relationships and plan to stay in the same neighborhood.

- **Place-identity and sense of belonging (Reg. Ch. 3)**

In CAL 1, the value on sense of belonging was slightly higher, which is possibly due to the perception of a higher personal attachment to a building rather than the larger neighborhood, which is the case in CAL 2 or CAL 3.

- **Citizen perceptions and concerns on safety and security of NBS interventions (Reg. Ch. 4).**

General concerns of citizen perceptions on safety and security were highly recorded in CAL 3, mainly related to lighting and clear visibility (71.7%), accessibility (67.4%), maintenance (81.5%) and the presence of security personnel and surveillance (69.6%), presence of green areas (48.9%) and presence of other people in the space (45.7%)

The following graphical representation of the wind-rose (Figure 8) aims to give evidence from the previous analysis on the most relevant categories of interest, hence correlating between social impacts from NBS and outcomes from the methodological analysis of the questionnaires' data. The legend indicates if the resulting percentage is representing results from all the three CALs or just one or two of them. For each sub-indicator, data was averaged and elaborated according to a new percentage scale (green <60%, yellow >60% and <70%, Orange >70% and <80%, Red >80%) to visually showcase the most important macro categories and micro indicators by consequences.

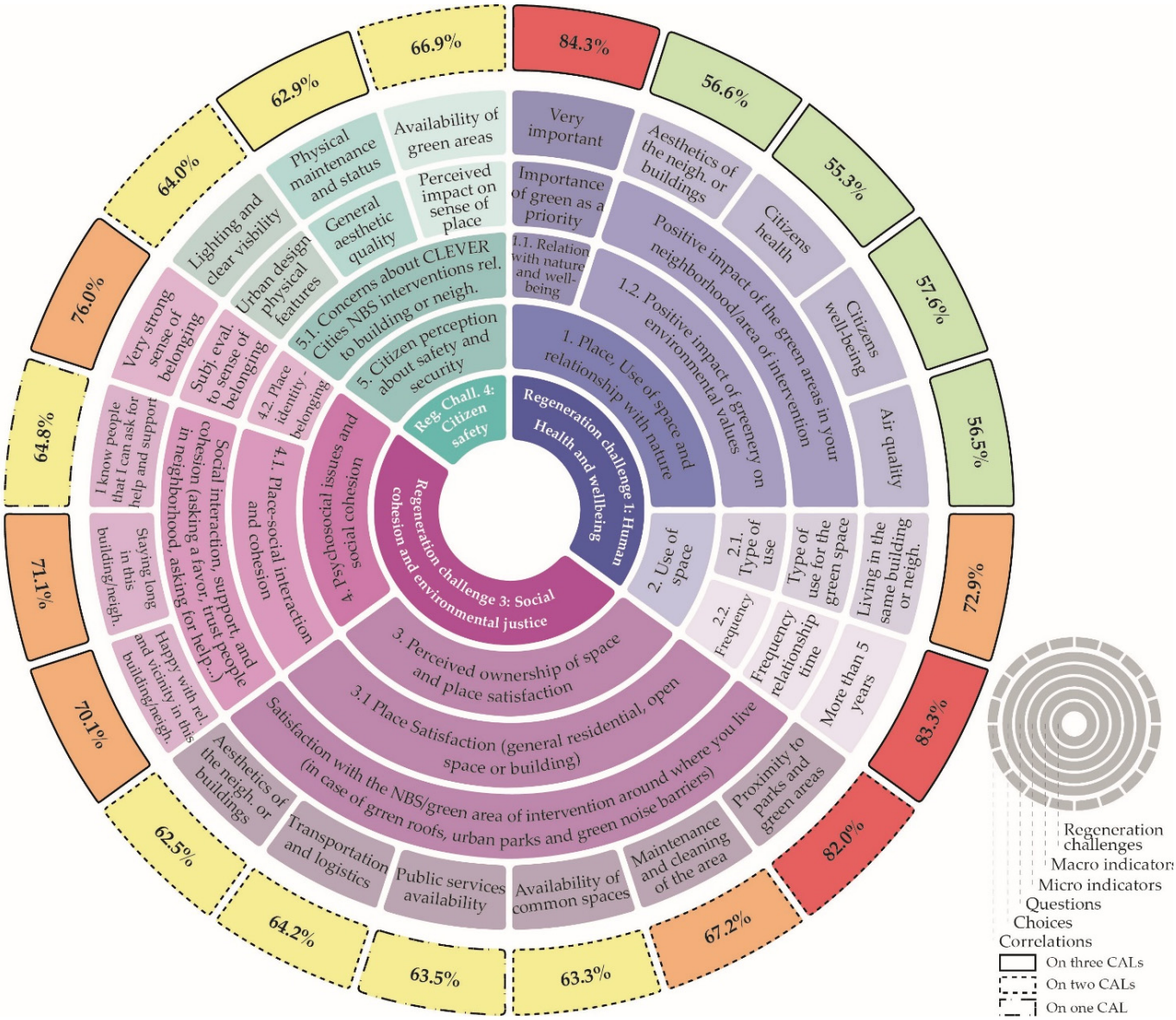


Figure 8. Wind-rose multi-model of co-benefits of NBS according to CLEVER Cities methodology. Considered data is the average percentage score for each indicator. Source: the first authors.

In relation to human health and wellbeing, it emphasizes the high importance of green infrastructure as a priority, medium positive impact from green areas on aesthetics, air quality and general wellbeing in residents' opinions. The model also reflects on the high connection of the relationship between residents and their permanence stability with the building and/or neighborhood where the CLEVER Cities interventions are taking place.

Reflecting on social cohesion and environmental justice, the model specifically investigates the clear high value of measuring aspects related to proximity to parks and green areas, maintenance and cleaning of the area with perception on general satisfaction and place ownership of one's building or neighborhood of residence. Commonly, the survey results guide a high social interaction in terms of happiness with relationship to vicinity and significant trust and support among the neighbors. Increased sense of belonging also results as an important aspect to focus on throughout the interventions in the CALs context.

Reflecting, then, on regeneration challenge 4 regarding safety and security, citizens' perceptions reveal high interest on maintenance, aesthetics and presence of other people in the green areas towards lowering their concerns on the areas of interventions related to

safety and security. However, general reflection on safety and security did not result as a priority in all three CALs equally but were overlooked on average in two CALs only.

The most striking result of this study is the high and widespread priority given by participants to proximity to green and natural elements within their urban environment, especially related to CLEVER interventions. This is irrespective of whether the interventions are carried out in buildings, train station environments or in urban public spaces itself. This result contrasts with the trend observed in recent decades in our cities of soil sealing and land consumption in our environments, eliminating green or blue elements, both in public spaces (elimination of trees, gardens, fountains...) and in our residential buildings, where flowerpots and small vegetation on balconies have been noticeably disappearing. What the public seems to be calling for is a return to greening and bluing our spaces of coexistence with nature. During the COVID-19 pandemic and, especially, during the period of confinement, the windows and balconies of our residential buildings have recovered their function as public spaces for enjoyment and social interaction.

To conclude, this research article aims to give evidence on the gap between methodological approaches towards measuring NBS social impacts. From the data analysis, it is clear that relevant KPIs from the practice carried throughout questionnaires emphasize the need to have a coherent simulation model from pre-greening and post-greening phases in order to cross-compare the increased or decreased social impacts of NBS. Moreover, the cross-comparability between the three different CLEVER Action Labs in Milan reflects on social inclusivity as the main aim of the CLEVER Cities project. Nonetheless, positive impact from proximity to green areas and connectedness to nature relate to an increased general wellbeing and satisfaction with one's building or neighborhood. It is valid to consider the application of NBS as a driver and catalyst in terms of social cohesion and wellbeing, but equally important is the engagement of citizens and voiceless groups in the implementation of NBS through a co-creation dimension.

Our aim from this methodological approach carried out throughout a year and a half of research on the theme of co-creation and co-implementation of such complex work is to reflect on the place-based needs emerging from social impacts related to NBS co-benefits. The evidence from literature is quite prominent, yet the evidence from practice-based on implemented projects is more valuable and quite remarkable. Future research will include implementing the same cross-comparative analysis on the post-greening phase after the implementation of the NBS interventions by the end of the year 2023.

Limitations

The research results also highlight the drawbacks of the long-term process of monitoring aspects related to social cohesion that make the results outdated by the end of the project lifetime. Another relevant drawback is the lack of unified measurement methodological framework when compared to other similar H2020 sister projects. The finding is emphasized from the work of Task Force II established on evaluating the NBS impact in place [21,90].

Another limitation on the general methodological approaches to social impacts related to project implementing NBS are the place-based constraints and relation to specific contextual attributes. In the case of CLEVER Cities, the project focuses on social inclusivity, which was emphasized by positive relationships in the different neighborhoods and pilot project areas.

Last, other noticeable limitations are the impossibility to measure accurate social benefits in quantitative terms except after the finalized project implementation and the conclusion of process evaluation. Meanwhile, the readings of the questionnaires and other instruments remain perceptual and are considered guidelines for the real implementation pathways.

Supplementary Materials: The methodological instrument and the data analysis details are available online at https://www.mdpi.com/article/10.3390/su13179672/s1. In addition, the following

Appendices are included as supplementary materials: **Appendix 01:** The Questionnaire templates in English. **Appendix 02:** Table of safety and security methodological analysis in CLEVER Cities Milan.

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